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# Current Science

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## CONTENTS



### *Letters to the Editor*

# INTERNATIONAL CONFERENCES

## 1. Third International Conference on Neurosecretion

THE concept that the nerve cells function as glandular units to bring about homeostasis and differentiation through chemical means of an endocrine nature, is of recent origin due to workers like the Scharrers, Bargmann and Hanström. The first symposium on this aspect of biological study, known as Neurosecretion, was organised in Naples in 1953, bringing together the active workers in the field for the first time. The histological and functional aspects of neurosecretory cells were discussed and the outcome of the symposium was the general acceptance of neurosecretion as a fundamental phenomenon in animals. The second symposium held in Lund in Sweden in 1957 brought out the functional significance of the secretory neurons in greater detail and this helped to formulate the existence of a neuro-endocrine system in animals.

The third International Conference on neurosecretion was held in Bristol in England from 8th to 13th September 1961. About sixty delegates, drawn from twelve nations including India, participated in this symposium. This Conference was divided into five sections and the papers presented and discussed covered structural and physiological aspects of the secretory neurons in both vertebrates and invertebrates.

One of the major subjects presented to the meeting related to the ultra-structure of the neurosecretory systems, revealed by studies using the electron microscope. Bern, Nishioka and Hagadoorn (Berkeley) presented an account of their studies on the neurosecretory cells of the leech, the cockroach, *Aplysia* and the frog, and demonstrated the relation between the golgi apparatus and the cellular secretion and the presence of neurofibrils in these cells. Knowles (Birmingham) described the ultra-structure of the neurohæmal organs known as pericardial organs of *Squilla*; while B. Scharrer (New York) and E. Scharrer and Brown (New York) presented their observations on the fine structure of the neurosecretory cells of the insect *Leucophæa* and the earthworm *Lumbricus* respectively.

Notable contributions relating to the comparative histology and histochemistry of vertebrate neurosecretory systems were from Arvy (Jouy-en-Josses) on the enzymatic histochemistry of the cells and from Howe (London) on the relation between arginine and neurosecretory colloids in the pituitary of mammals. The observable relationship between the neurosecretory activity, photoperiodism and the cyclical activity of the testes of the sparrow presented by Farner (Pullman) and Oksche (Kiel); the effect of dehydration on the development of hypothalamic centres controlling water metabolism by Rodeck (Datteln); the physiological changes in the neurosecretory system of the fish by Stahl and Leray (Marseille); and the demonstration of the distribution of the hormones oxytocin and vasopressin in the mammalian hypothalamic nuclei by Lederis (Bristol) formed some of the significant presentations revealing the physiology of the neurosecretory cells in vertebrates.

Three sessions were devoted to the papers on invertebrate neurosecretion. The histology and histophysiology of the system in Annelida were presented in the works of Herlant-Meewis (Brussels) who showed the relationship between regeneration and neurosecretory phenomena in *Eisenia*; of Clark, Clark and Ruston (Bristol) on similar phenomena in polychæts; of Clark (Bristol) who brought out evidences to show the influence of neurosecretion on growth and reproduction in polychæts; and of Hagadoorn (Berkeley) who described the neurosecretory phenomena in the leech *Theromyzon*.

Neurosecretion in insects were studied essentially from the histophysiological and embryological points of view. Lea (Vero Beach) and Thomsen (Copenhagen) described the cyclical activity of secretion as revealed by dark ground microscopy, in the median neurosecretory cells of the brain of the blowfly; Khan and Fraser (Glasgow) described the developmental history and influences of the neurosecretory cells of the brain in the embryos of the cockroach *Periplaneta*; and Nayar (Trivandrum) described the probable inhibitory effect of the juvenile hormone-extracts on the release of neurosecretory material into the blood of the cockroach comparable to conditions of hydration in insects. Arvy (Jouy-en-Josses) and Gabe (Paris) described the histochemistry of the neurosecretory cells and the corpora cardiaca of several insect groups. Highnam (Sheffield) presented a resume of his work on the desert locust demonstrating the influence of neurosecretory activity on the ovarian development and the initial experiments using radioisotopes to follow up the pathways of this influence.

Two papers dealt with neurosecretion in crustaceans. Bliss (New York) described the complex endocrinological control of locomotor activity in the crab *Gecarcinus;* and Menon (Trivandrum) gave an account of the neurosecretory cells of the branchiopod *Streptocephalus* recognising the existence of two specific structures as storage centres, one like a sinus gland within the eyestalk with the neurosecretory cells within the brain, and the other the frontal organs hitherto attributed with a varied function.

Prabhu (Trivandrum) described the neurosecretory system of the millipede *Jonespeltis* giving an account of the cells, their distribution and seasonal variations together with an account of a double storage centre in the connective body and the cerebral gland. Naisse (Brussels) gave an account of the neurosecretory cells and their structure and distribution in the opilionids.

In addition to these contributions, brief reports on research topics were also presented, in two afternoon sessions, covering aspects of neurosecretory histology and physiology in both vertebrates and invertebrates.

The Conference terminated with a closing address by E. Scharrer (New York). He stressed the significance of the neurosecretory cells in the organisation and physiology of the nervous system of animals and pointed out that the basic pattern of the neuro-endocrine system in animals is that of the glandular neurons and connected storage organs. In reply to a statement by de Robertis (Buenos Aires) made earlier in the Conference that nerve cells are all capable of producing substances and so all neurons are neurosecretory cells, he affirmed that though neurons can elaborate the neurohumours facilitating neuronal transmission, the neurosecretory cells do form a distinctive category of neurons both in their anatomy and physiology. They have to be dealt with separately as essential endocrine units.

The proceedings of the symposium will be published as Memoir No. 12 of the Society for Endocrinology.

As the host institution, the University of Bristol was courteous and friendly. Drs. Clark and Heller as the Organising Secretaries endeared themselves to all who participated in the symposium. There was a high degree of informality in the Conference. Most valuable of all was the chance to meet and talk with workers from the different parts of the globe and the exchange of ideas with the people was indeed rewarding. Especially enjoyable was the trip to Avebury, where in a charming setting of old Britain of the times of Queen Elizabeth I in the Avebury Manor, the delegates were accorded a lordly reception by Sir Francis and Lady Knowles.

K. K. NAYAR.

### 2. First International Conference on Protozoology

Under the joint auspices of the Society of Protozoologists and the Czechoslovak Academy of Sciences, the First International Conference on Protozoology was held in the Hotel International, Prague, Czechoslovakia, from August 22nd to 31st, 1961. It was attended by over 200 protozoologists from several countries, including U.S.A., U.S.S.R., U.K., West and East Germany, France, Poland, Rumania, Hungary, Czechoslovakia, Japan and Egypt. A particularly large contingent of senior protozoologists came from U.S.S.R. including Professors Moshkovski, Cheissin and Poljanski. Prof. Garnham came from U.K. But the largest number was from U.S.A. and included Von Brand, Hutner, Trager, Tartar, Corliss and many others. India was represented by Prof. B. R. Seshachar and a number of younger workers.

The Conference was opened on the afternoon of August 22nd by Prof. I. Malek, Vice-President of the Czechoslovak Academy of Sciences. The languages of the Conference were Czech, Russian, English, French and German. Simultaneous translation facilities were available.

The morning session of the first working day was devoted to papers on the Taxonomy of Protozoa. It was clear that with the increasing knowledge of the Protozoa made available by the employment of newer techniques, some of the older views in regard to taxonomic relationships of Protozoan groups would merit revision. This was particularly well brought out by a number of workers like Corliss, Moshkovski and Honigberg. The afternoon session was devoted to papers on the Genetics of Protozoa. Siegel's paper on gene function and sexuality in *Paramecium bursaria* revealed that sexuality in this species was governed by genes at two loci and that immaturity, adolescence and maturity were expressions of these genes. The second day was devoted to papers on biochemistry of Protozoa and began with a talk by Von Brand on Achievements and goals in Protozoan biochemistry. Hutner's discussion on the role of Carbohydrates in the nutrition of Ciliates and flagellates was followed by a number of papers on the metabolic requirements of Protozoa,

notably by Johnson, Seaman, Schmoller, Trager and Provasoli. The cytology of Protozoa was dealt with in the morning session on the 25th August with papers by Dutta, Hawes, Seshachar and Tuffran. Raikov dealt with the problem of nuclear dualism in ciliates. The afternoon of that day was devoted to biophysics and a number of papers by Zeuthen and his colleagues from Copenhagen on Synchronization methods by temperature and other shocks were read, followed by papers on X-ray irradiation by Wichterman and Daniels. Dryl of Warsaw gave illustrations of movement of Paramecia in electromagnetic fields.

The Conference broke up into two sections on the morning of the 26th August. One occupied itself with discussion of papers on the Ecology of Protozoa while the other was devoted to Taxoplasmosis. Dr. E. Lund showed a beautiful film of *Taxoplasma* living cultures, illustrating the morphology, movement and reproduction in the organism. The Conference recessed on Saturday afternoon and Sunday. A sight-seeing trip of Prague was organized for Saturday afternoon and a whole day excursion to Karlovy-Vary and Marianske-Lazne was arranged on Sunday.

The Conference reassembled on Monday the 28th August for a day's discussion on Electron microscopy of Protozoa. Following Ludvik's paper, those of Pyne, Pappas, Yagiu and others showed the Conference the great advances in our knowledge of the ultra-structure of Protozoa. The last two working days of the Conference, *i.e.*, 29th and 30th August, were devoted to papers dealing with the structure, life-history and host-parasite relationships of parasitic Protozoa. With the formal final session on the 31st the Conference came to a close.

It was the unanimous opinion of all those present that the Conference was helpful in bringing together workers in different aspects of Protozoan structure, life-history and relationships. Prof. O. Jirovec and his colleagues of the Protozoology Laboratory, Czechoslovak Academy of Sciences, spared no pains to make the delegates comfortable and the first Conference on Protozoology a great success.

B. R. S.

## VOSTOK II—RUSSIA'S SECOND MANNED SPACE-SHIP

ON August 6, 1961, at 9 am. Moscow Time, the Soviet Union launched a new space-ship "Vostok II" on a round-the-earth orbit with a man aboard. The pilot was Major Gherman Titov.

The tasks of the flight were: To study the effects on the human body of prolonged oribital flight and descent to the surface of the earth; to study man's work capacity during a sustained state of weightlessness.

The space-ship was put into an orbit close to the calculated one, with the following parameters: Minimum distance from the surface of the earth (at perigee) was 178 kilometres; maximum distance (at apogee) was 257 kilometres; the inclination of the orbit to the equator was 64 degrees 56 minutes.

The initial period of revolution of the space-ship was 88·6 minutes. Minus the weight of the last stage of the carrier-rocket the space-ship weighed 4,731 kilograms.

Two-way radio communications were maintained with cosmonaut Titov. The cosmonaut transmitted on frequencies of 15·765, 20·006, and 143·625 megahertz. A transmitter "signal" operating on frequency of 19·995 megahertz was also on board the space-ship. The systems on board sustaining the cosmonaut's vital activity functioned normally. The cosmonaut felt well throughout the flight and the controlled flight proceeded successfully.

Upon the successful completion of its programme of scientific research, the space-ship, in accordance with the approved flight programme, came to land at a pre-assigned spot in the Soviet Union, near the place where the space-ship "Vostok I" piloted by Major Yuri Gagarin, landed on April 12, 1961.

"Vostok II" made over 17 circuits around the earth in 25 hours 18 minutes, covering a distance of over 700,000 kilometres.

In the landing of the space-ship at a pre-assigned spot, the effect of the rotation of the earth will have to be taken into account. The landing of the space-ship on Soviet soil could have been effected after its first round, or, if that is missed, the cosmonaut should wait for 24 hours, when the earth would have turned once under him,—before he could land at the pre-assigned spot in Soviet territory. Thus Vostok I with Major Gagarin landed after one orbital round, whereas the space dogs, Strelka and Belka, which Russia launched on August 19, 1960, spent 24 hours in the space-ship, making 17 complete orbits, before the capsule containing them was brought down.

# MULTIVARIABLE CONTROL SYSTEMS IN THE LIGHT OF SYMMETRICAL COMPONENTS

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THE major obstacle in the analysis and synthesis of multivariable control systems is the presence of strong interaction between the controlled variables. In the existing literature[1-3] compensating matrices have been used to obtain non-interacting system, i.e., a system in which one-to-one relationship exists between the outputs and the respective commands. But the general multivariable system, without being compensated by the use of additional elements, has not been discussed from the point of view of stability limits.

The approach developed in this communication, which is fundamentally different from the existing methods, is based on the analogy between multivariable control systems and polyphase electric circuits. Thus the interaction appearing in multivariable systems can be advantageously studied in the light of symmetrical component theory which has been so widely and successfully used in the domain of polyphase circuits involving strong mutual coupling between phases. Hence for purposes of analysis and synthesis, an interacting system can be replaced by an equivalent set of non-interacting or feebly interacting systems. For these systems, stability analysis can be carried out conveniently on the basis of root locus or Nyquist criterion.

A multivariable feed-back control system is defined as a system which forms $n$ output variables $(y_1, y_2 \ldots\ldots y_n)$ from $m$ input variables $(x_1, x_2 \ldots\ldots x_m)$, so as to satisfy $n$ equations of the form

$$F_i(y_1, \cdots y_n, x_1 \cdots x_m) = 0 \quad i = 1 \text{ to } n. \quad (1)$$

In terms of Laplace transforms, the equation of a single variable control system with forward transfer function G and unity feed back is given by

$$Y = RX, \quad R = \frac{G}{1+G} \quad (2)$$

or

$$X = R^{-1}Y = TY. \quad (3)$$

X, Y, R, T are respectively Laplace transform of command input, output, system transfer function and the inverse system transfer function.

The analogue of equation (2) in circuit analysis is the equation of single phase circuit

$$E = ZI \quad (4)$$

where
E is impressed voltage,
Z is impedance of the circuit,
I is response current.

In the case of general multivariable control system, the governing equation of the system is given by

$$X = [J^{-1}G^{-1}(1 + JGH)]\,Y = TY \quad (5)$$

where
J is the coupling matrix,
G is the diagonal matrix, and
H is the feed back matrix (diagonal).

Its analogue in circuit analysis is the equation of polyphase circuit

$$E = ZI \quad (6)$$

where
X, Y, E, I are all column matrices,
T, Z are square matrices,
T = inverse system transfer matrix,
Z = system impedance matrix.

It can be easily seen that Z and T have similar properties and the problems in the two fields can be classified according to the nature of Z or T matrix.

TABLE I

| Type | Diagonal terms | Non-diagonal terms | Nature of system |
|---|---|---|---|
| 1 | $Z_{11}=Z_{22}=Z_{33}$ | $Z_{mn}=0$ | Symmetrical ; non-interacting |
| 2 | $Z_{11}\neq Z_{22}\neq Z_{33}$ | $Z_{mn}=0$ | Unsymmetrical ; non-interacting |
| 3 | $Z_{11}=Z_{22}=Z_{33}$ | $Z_{mn}\neq 0$ | Quasi-symmetrical ; interacting |
| 3A | $Z_{11}=Z_{22}=Z_{33}$ | $Z_{12}=Z_{23}=Z_{31}$ $Z_{21}=Z_{32}=Z_{13}$ | Symmetrical ; interacting |
| 4 | $Z_{11}\neq Z_{22}\neq Z_{33}$ | $Z_{mn}\neq 0$ | Unsymmetrical ; interacting |
| 4A | $Z_{11}\neq Z_{22}\neq Z_{33}$ | $Z_{12}=Z_{23}=Z_{31}$ $Z_{21}=Z_{32}=Z_{13}$ | Only interaction is symmetrical |

Problems of type 1 and 2 have presented no difficulty in both control systems and circuit analysis (or power system analysis). The majority of problems occurring in power system analysis is of type 3, 3 A. The method of symmetric components[4] can be used elegantly for problems of type 3 A and 3. There is no elegant method for tackling problems of type 4, 4 A in power system analysis.

The object of this paper is to extend the theory of symmetrical components to the domain of control systems and hence solve problems of type 3 A and 3 in control systems. Next, a general method is evolved involving symmetrical components to tackle problems of type 4 A (where interaction is symmetrical) and problems of type 4 (general unsymmetrical case) to a certain extent. The method of solution for problems involving complete symmetry and interaction (Type 3 A) is to apply Fortescue's transformation to equation (5) and to get an equivalent non-interacting system characterised by the matrix T′ called as sequence transfer matrix. As T′ has only diagonal terms, it can be analysed for stability limits, etc., by root Locus or Nyquist charts. This method can be applied to problems of type 3 as well, except that sequence transfer matrix T′ has non-diagonal terms also. They can be neglected if they are feeble (which is usually the case) and analysis carried out as before.

For problems of type 4 A (where only interaction is symmetrical) the procedure would be to split up the matrix T into two matrices $T_s$ and $T_M$. $T_s$ has only diagonal terms and $T_M$ has only non-diagonal (and symmetrical) terms. As $T_s$ is a diagonal matrix, it can be treated by usual methods. As $T_M$ is symmetrical, the theory of symmetrical components can be applied to it so that the resultant sequence transfer matrix $T_M'$ has only diagonal terms and hence can be solved by usual methods. This method can be extended to problems of type 4 (general unsymmetrical case), only if the mutual terms of $T_M'$ are feeble.

For illustration, the method is applied to the problem of the turbo-jet engine (which is of type 4—completely unsymmetrical case) for which experimental verification is available.[5]

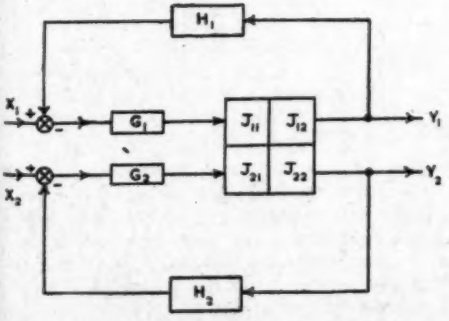


FIG. 1. Two-dimensional control system for the turbo-jet engine.

The variables to be controlled are the speed of rotation and turbine inlet temperature. The two plant inputs are fuel flow and exhaust nozzle area. The interaction is there, as a disturbance in fuel flow or exhaust nozzle area causes both the speed as well as the temperature to change. The block diagram is shown in Fig. 1. The figure is self-explanatory. Matrix J is the engine matrix which causes the interaction. $G_1$, $G_2$ are forward transfer functions, $H_1$, $H_2$ are feed-back transfer functions. Using matrix notation in $s$-plane,

$$Y = JGE$$
$$= JG\,(X - HY) \qquad (7)$$
$$(1 + JGH)\,Y = JGX$$

or

$$X = [G^{-1}J^{-1}\,(1 + JGH)]\,Y \qquad (8)$$
$$= TY \qquad (9)$$
$$T = G^{-1}J^{-1}\,(1 + JGH)$$
$$= G^{-1}J^{-1} + H$$

$$= \begin{vmatrix} \frac{1}{G_1} & 0 \\ 0 & \frac{1}{G_2} \end{vmatrix} \cdot \begin{vmatrix} \frac{J_{22}}{\Delta} & \frac{-J_{21}}{\Delta} \\ \frac{-J_{12}}{\Delta} & \frac{J_{11}}{\Delta} \end{vmatrix}$$

$$+ \begin{vmatrix} H_1 & 0 \\ 0 & H_2 \end{vmatrix}, \qquad (10)$$

wherein,

$$\Delta = J_{11}J_{22} - J_{12}J_{21}.$$

Simplifying

$$T = \begin{vmatrix} \frac{J_{22}}{G_1\Delta} + H_1 & \frac{-J_{21}}{G_1\Delta} \\ \frac{-J_{12}}{G_2\Delta} & \frac{J_{11}}{G_2\Delta} + H_2 \end{vmatrix} \qquad (11)$$

$$= T_s + T_M. \qquad (12)$$

$$T_s = \begin{vmatrix} \frac{J_{22}}{G_1\Delta} + H_1 & 0 \\ 0 & \frac{J_{11}}{G_2\Delta} + H_2 \end{vmatrix}$$

$$= \begin{vmatrix} T_{11} & 0 \\ 0 & T_{22} \end{vmatrix}. \qquad (13)$$

$$T_M = \begin{vmatrix} 0 & \frac{-J_{21}}{G_1\Delta} \\ \frac{-J_{12}}{G_2\Delta} & 0 \end{vmatrix} = \begin{vmatrix} 0 & T_{12} \\ -T_{21} & 0 \end{vmatrix} . \quad (14)$$

$$X = (T_S + T_M)\, Y = X_S + X_M. \quad (15)$$

Splitting up equation (15) into 2 parts

$$X_S = T_S Y ; \quad (16)$$

$$X_M = T_M Y. \quad (17)$$

Consider equation (17). It is quasi-symmetrical (Type 3). We can apply the theory of symmetrical components. For two-phase network, Fortescue's transformation matrix A is given by[6]

$$A = \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} ; \; A^{-1} = \frac{1}{2} \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} . \quad (18)$$

Operating Fortescue's matrix on $X_S$ and Y

$$\left.\begin{aligned} X_S &= AX_S' \\ Y &= AY' \end{aligned}\right\} . \quad (19)$$

Substituting (19) in (17)

$$AX_S' = T_M AY'$$

or

$$X_S' = [A^{-1}T_M A]\, Y' \quad (20)$$

$$= T_M' Y'. \quad (21)$$

Sequence transfer matrix

$$T_M' = A^{-1}T_M A$$

$$= \frac{1}{2} \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix} \cdot \begin{vmatrix} 0 & T_{12} \\ -T_{21} & 0 \end{vmatrix} \times \begin{vmatrix} 1 & -1 \\ 1 & 1 \end{vmatrix}$$

$$= \frac{1}{2} \begin{vmatrix} T_{12}+T_{21} & T_{12}-T_{21} \\ T_{12}-T_{21} & T_{12}+T_{21} \end{vmatrix} . \quad (22)$$

The term $(T_{12}-T_{21})$ is the difference of two interaction effects. Hence its strength is small when compared to that of $(T_{12}+T_{21})$ and can be neglected.

$$T_M' = \frac{1}{2} \begin{vmatrix} T_{12}+T_{21} & 0 \\ 0 & T_{12}+T_{21} \end{vmatrix} \quad (23)$$

and

$$X_M' = T_M' Y'. \quad (24)$$

Therefore stability of this system can be determined from the zeroes of diagonal elements of $T_M'$.

*i.e.*,

$$(T_{12}+T_{21}) = 0. \quad (25)$$

Now equation (16) is considered. It is a non-interacting system and its stability is given by the zeroes of the diagonal elements,

*i.e.*,

$$T_{11} = 0 \quad (26)$$

and

$$T_{22} = 0. \quad (27)$$

Equations (25), (26) and (27) are the characteristic equations of the system.

The transfer functions used are

$$J_{11} = \frac{0{\cdot}32}{1+1{\cdot}75s}; \quad J_{12} = \frac{0{\cdot}618}{1+1{\cdot}75s} \quad (28)$$

$$J_{21} = \frac{0{\cdot}248\,(1+3{\cdot}17s)}{1+1{\cdot}75\,s};$$

$$J_{22} = \frac{-0{\cdot}417\,(1+0{\cdot}07s)}{1+1{\cdot}75s} \quad (29)$$

$$G_1 = K_N \frac{(1+1{\cdot}75\,s)}{1{\cdot}75\,s} \cdot \frac{31{\cdot}3}{(1+0{\cdot}10s)^2} \quad (30)$$

$$G_2 = -K_T \frac{(1+1{\cdot}75s)}{1{\cdot}75s} \cdot \frac{2{\cdot}4}{(1+0{\cdot}3s)\,(1+0{\cdot}15s)} \quad (31)$$

$$H_1 = \frac{1}{1+0{\cdot}05\,s}; \quad H_2 = \frac{1}{1+s} \quad (32)$$

$$\Delta = J_{11}J_{22} - J_{12}J_{21} = -\frac{(0{\cdot}286+0{\cdot}495s)}{(1+1{\cdot}75\,s)^2} . \quad (33)$$

Simplifying equation (25); (*see* footnote)*

$$T_{11} = \frac{E_{22}}{G_1\Delta} + H_1$$

$$= \frac{E_{22}}{G_1\Delta}\left(1 + \frac{G_1H_1\Delta}{E_{22}}\right) = \frac{E_{22}}{G_1\Delta}\, T_{11}'. \quad (34)$$

All the information given by $T_{11}=0$ is also given by $T_{11}'=0$ as $G_1$ $G_2$, $\Delta$, etc., have no poles in the right half of $s$-place.

Therefore

$$T_{11}' = 1 + \frac{G_1H_1\Delta}{E_{22}} = 0.$$

On substituting equations (28) to (33), the above equation becomes

$$T_{11}' = 1 + \frac{K_N \times 6{\cdot}1 \times 10^5 (s + 0{\cdot}576)}{s (s+10)^2 (s+14{\cdot}3) (s+20)} = 0. \quad (35)$$

Similarly

$$T_{22} = \frac{E_{11}}{G_2\Delta} + H_2 = \frac{E_{11}}{G_2\Delta}\left(1 + \frac{G_2H_2\Delta}{E_{11}}\right) = \frac{E_{11}}{G_2\Delta} T_{22}'$$

where

$$T_{22}' = 1 + \frac{G_2H_2\Delta}{E_{11}}.$$

On simplification, it becomes

$$T_{22}' = 1 + \frac{47 K_T (s + 0{\cdot}576)}{s (s+1) (s+3{\cdot}33) (s+6{\cdot}66)} = 0. \quad (36)$$

Similarly,

$$T'_2 + T_{21} = \frac{-E_{21}}{G_1\Delta} + \frac{E_{12}}{G_2\Delta} = \frac{-E_{21}}{G_1\Delta}\left(1 - \frac{G_1}{G_2} \cdot \frac{E_{12}}{E_{21}}\right) = \frac{-E_{21}}{G_1\Delta} T_{12}' = 0$$

$$T_{12}' = 1 - \frac{G_1}{G_2} \cdot \frac{E_{12}}{E_{21}} = 1 + \frac{4{\cdot}6 K_N}{K_T} \frac{(s+3{\cdot}33)(s+6{\cdot}66)}{(s+10)^2 (s+0{\cdot}315)} = 0. \quad (37)$$

Hence the effective characteristic equations are given by (35), (36) and (37).

Each of them is analysed by plotting Evan's root Locus (or Nyquist Chart). The maximum allowable values of $K_N$, $K_T$ and $K_N/K_T$ and their variation are found from Locus charts of (35), (36) and (37) respectively. Using these, a graph of maximum value of $K_N$ allowed for each value of $K_T$ can be plotted. This gives the region of stability. It is found that the stability graph found by analysis is confirmed by that found by experiment. However, the region of stability given by the analysis is conservative when compared with the experimental investigations of Pack and Phillips.

### Conclusions

(i) Mechanism of interaction has been analysed by means of theory of symmetrical components.

(ii) The general unsymmetric system has been separated into two systems—one having only self or diagonal terms and the other having only mutual terms. The stability of the former can be discussed directly, while that of latter can be analysed only after applying symmetrical components.

(iii) Stability limits can be found out on the basis of root Locus or Nyquist criterion.

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* $E_{ij} = J_{ij}$, for $i = 1, 2$ and $j = 1, 2$.

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## FREE RADICALS IN CRYSTALS

Highly reactive 'free radicals', containing an odd electron unaccompanied by its partner with opposed direction of spin, may be produced when high energy radiation falls on organic crystals. These radicals readily form spin-paired molecules when the solid is dissolved or melted, but if held in the rigid solid they will last up to several months and can be studied directly by means of electron spin resonance spectroscopy.

The main spectroscopic transition is the reversal of the electron spin direction in a strong magnetic field by means of a quantum of microwave radiation. When the radical which holds the electron also contains nuclei which are intrinsic magnets (*e.g.*, H, $^{13}C$, $^{14}N$) a splitting occurs and hyperfine pattern of several lines is produced. Detailed interpretation of the number, positions and intensities of such lines gives information about nuclei present in the radical.

The most interesting of the new radicals so far discovered has been the ionic species $CO_2^-$ produced by the effect of gamma rays on sodium formate. Since the dominant isotopes $^{12}C$ and $^{16}O$ are nonmagnetic, proof of the species was obtained by observing the 1% of radicals containing the isotope $^{13}C$.—(*Research*, 1961, **14**, 336.)

# SYNTHESIS OF *p*-BENZOHYDROQUINONE-1-$C^{13}$

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*and*
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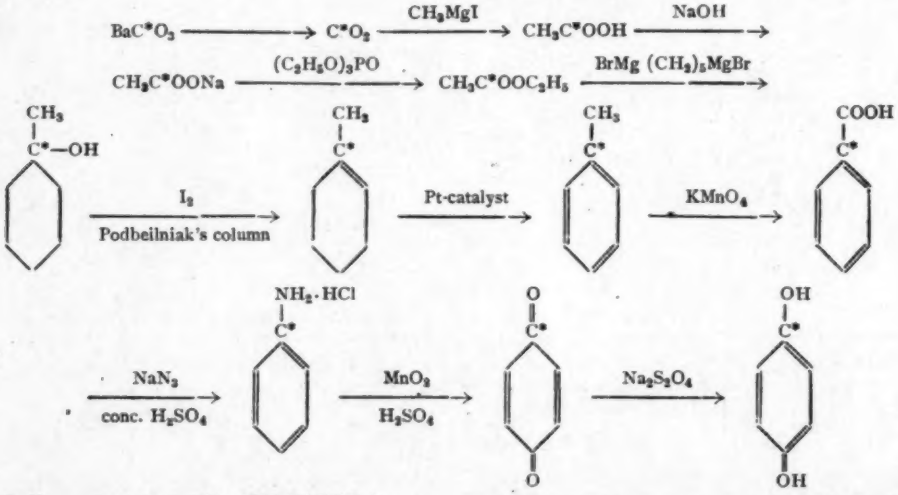
THE synthesis of hydroquinone labelled with $C^{13}$ at the several positions has been undertaken for the purpose of studying the nature of the $C^{13}$ hyperfine interactions in the corresponding semiquinone ions; the semiquinone ions are obtained by the atmospheric oxidation of an alkaline solution of the hydroquinone in ethanol. The *hfs* due to $C^{13}$ in natural abundance has been reported in semiquinone ions[1] but has not been confirmed by studies on $C^{13}$-enriched compounds. The synthesis of *p*-benzohydroquinone-1-$C^{13}$ has been completed and the labelled compound has been obtained for the first time. It involved the following sequence of reactions:




1. *Sodium Acetate-1-$C^{13}$ ($CH_3C^*OONa$)*

The conversion of $BaCO_3$ (enriched in $C^{13}$ to about 48%) to sodium acetate was performed in a reaction vessel which was a modified version of the one used by Sakami, Evans and Gurin.[2] It consisted of a three-necked flask, to one neck of which was attached a small bent tube of 10 ml. capacity; in this tube the generated carbon dioxide was solidified using liquid air. Carbon dioxide generated from 10 gm. of $BaC^*O_3$ (48% enriched in $C^{13}$) using 70 ml. of conc. $H_2SO_4$ was solidified in the cold limb. The use of conc. $H_2SO_4$ avoids the necessity of a separate drying tube. To ensure the expulsion of any dissolved gas, the carbon dioxide generator was heated until the barium sulphate dissolved in the excess acid.

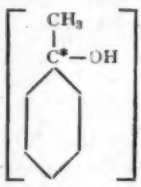
The carbon dioxide generator was then disconnected from the reaction vessel without disturbing the vacuum and the side tube containing the solid $CO_2$ was allowed to warm up. The Grignard reagent, which was prepared from 2·5 gm. of Mg, 7 ml. of distilled $CH_3I$ and 275 ml. of anhydrous ether, was added slowly while the bulb was cooled with a mixture of ice and salt. Since the amount of $BaCO_3$ was such that the pressure developed by carbon dioxide was less than the atmospheric pressure, the Grignard reagent was slowly sucked in when the stop-cock was opened. After the reaction was complete, the mixture was poured over 300 gm. of crushed ice and dilute sulphuric acid (7 ml. of conc. $H_2SO_4$ + 50 ml. of water) was added to dissolve the magnesium salts. The ether was evaporated off with a stream of air and 28 gm. of silver sulphate was added to the mixture. 25 ml. of conc. $H_2SO_4$ was then added gradually and the resulting solution was steam-distilled. Enough sodium hydroxide solution was added to the distillate to bring its pH to 8·8 and then it was slowly evaporated. When almost all the water had gone, the syrupy mass was transferred to a small flask and dried under

vacuum at about 100° C. The solid was finally dried for 3 hours at 110–120 ° C. under a pressure of 0·5 $\mu$.[3] Yield : 2·83 gm. ; 68%.

2. *Ethylacetate*-2-$C^{13}$ ($CH_3C^*OOC_2H_5$)

Sodium acetate was converted to ethylacetate using triethyl phosphate.[3] The alkyl phosphate was preferred to the sulphate as it has a higher boiling point and is more stable at temperatures near 200° C. 9·8 gm. of the labelled anhydrous sodium acetate and 38 ml. of distilled ethyl phosphate was refluxed in a 250 ml. flask for an hour at 170–220° C. ; an air-condenser followed by a small water condenser cooled with ice-cold water was used to avoid loss of the labelled acetate. The reaction mixture was kept overnight at room temperature and again refluxed for 2 more hours. The ethyl acetate was isolated as described by Ropp.[3] Yield : 9·55 gm. ; 90·7%.

3. *Methyl Cyclohexanol*-1-$C^{13}$



This was prepared according to the method described by Fields, Leaffer and Rothchild[4] starting with 9·5 gm. of ethyl acetate. Yield : 6·61 gm. ; 53·0%.

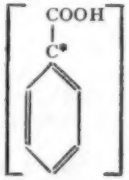
4. 1-*Methyl Cyclohexene*-1-$C^{13}$

The dehydration of the tertiary alcohol was carried out using a Podbeilniak's column,[4,5] in which glass coils were used in the place of copper coils. Starting with 6·6 gm. of the alcohol, yield : 2·2 gm. ; 40·1% ; $n_D^{25} = 1·442$.

5. *Toluene*-1-$C^{13}$

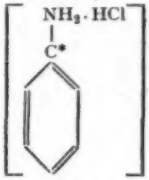
The dehydrogenation was carried out using 30% platinum-on-asbestos catalyst in place of the "Universal Oil Products" catalyst.[4] Though the toluene obtained with Pt and Pd catalysts is not of very high purity,[4] this was sufficient for further conversion to benzoic acid. With 2·1 gm. of methylcyclohexene, yield of toluene 1·35 gm. (67·7%) ; $n_D^{25} = 1·481$.

6. *Benzoic*-1-$C^{13}$ *acid*



1·25 gm. of the toluene obtained was added without further purification to a solution of 5·1 gm. of potassium permanganate in 75 ml. water containing 0·3 gm. of sodium hydroxide and the side-chain oxidation was carried out in the usual manner.[6] Yield : 0·91 gm. (54·4%) ; m.p. = 121·5° C.

7. *Aniline*-1-$C^{13}$ *hydrochloride*



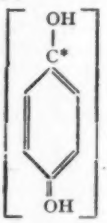
0·85 gm. of benzoic acid was converted to aniline hydrochloride by the Schmidt reaction according to the method described by Fields, Rothchild and Leaffer.[7] An excess of sodium azide (2·5 moles per mole of acid) was used, as this excess was found to increase the yield to a considerable extent. Yield : 0·77 gm. ; 85·4% ; m.p. = 195° C.

8. p-*Benzoquinone*-1-$C^{13}$

0·77 gm. of aniline hydrochloride was dissolved in 28 ml. of water containing 2·8 ml.

conc. $H_2SO_4$ (96%); 5·5 gm. of $MnO_2$ was added and mixed by shaking. The mixture was immediately steam distilled and the distillation was continued until the distillate was colourless. The distillate was extracted several times with ether; the ether extract was dried over anhydrous sodium sulphate and evaporated to yield quinone. Yield: 0·33 gm.; 51·6%.

9. p-*Benzohydroquinone*-1-$C^{13}$




The ether solution of the quinone was reduced to the hydroquinone using a solution of sodium hydrosulphite.[8] The ether layer after separation was dried with anhydrous sodium sulphate. After drying it was allowed to evaporate and the residue was crystallised from alcohol. Yield of pure crystalline product: 0·171 gm. (50·9%); m.p. = 170° C.

The hyperfine structure found in the electron spin resonance spectrum of the semiquinone ion derived from the labelled hydroquinone has confirmed the presence of one $C^{13}$ atom in the ring (with an enrichment of about 50%).[9]

ACKNOWLEDGEMENT

It is a pleasure to acknowledge that the problem was suggested by Dr. B. Venkataraman. The author is thankful to Professor S. S. Dharmatti for his keen interest in the work, Dr. B. Venkataraman for many helpful suggestions and Shri M. V. Krishnamurthy for help in the synthesis.

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## EARTH'S CRUST UNDER INDIAN OCEAN

REPORTS on the scientific results of the two expeditions in the Soviet ship *Vityaz* in the Indian Ocean in 1959-61 were presented by Dr. Bezrukov, leader of the expedition, at the session of the Presidium of the Soviet Academy of Sciences held on August 25, 1961. For the first time it has been possible to obtain some details regarding the thickness, structure and relief of the earth's crust under the Indian Ocean. In studying the relief of the ocean floor several hitherto unknown submarine mountains and ranges have been discovered. Explorations have shown that rocks of volcanic origin occupy a large proportion of the bottom of this vast water basin. Investigations of composition and structure have revealed that in the southern part are present massive accumulations of iron-manganese ores containing up to 0·5% nickel, cobalt and other rare metals.

The fauna of the Indian Ocean is very varied and scientists on board the *Vityaz* have collected a large number of animals and fish living on the ocean bottom, among which are many that are little explored or absolutely unknown. Study of the chemistry of water at different areas of the ocean has shown that the amount of oxygen in a greater part of the Indian Ocean is sufficient for the life of fishes and marine animals. The only exceptions are the Arabian Sea and the Bay of Bengal, where oxygen content drops to zero in some places. This is explained by insufficient vertical circulation of water in those areas. Here also the explorers detected large amounts of hydrogen sulphide. Promising fisheries have been discovered during the expeditions, specifically large tuna fisheries south of Indonesia.

The *Vityaz* expeditions were held under the international programme for the exploration of the Indian Ocean, and formed one of the first marking the beginning of further explorations of the Indian Ocean. *Vityaz* had twelve scientific teams of diverse interests functioning on board.—(*USSR News.*)

# ON THE LOCATION OF SPAWNING GROUNDS OF INDIAN SHAD, *HILSA ILISHA* (HAMILTON) IN FRESHWATER REGIONS OF THE NARBADA RIVER

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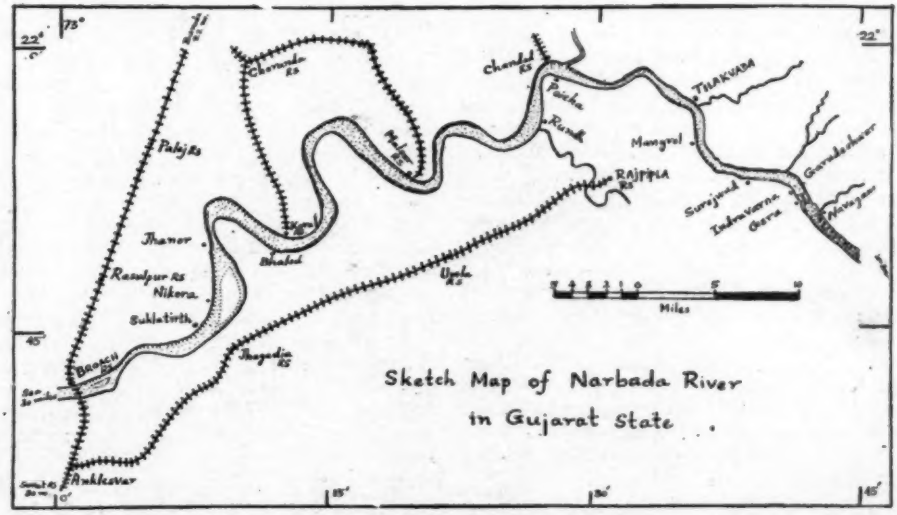
WHILE upstream migration of *Hilsa ilisha* (Hamilton) in the Narbada river is reported up to tidal limit near Bhalod, about 50 miles from sea, a few shoals are known to penetrate freshwater as far as Gora which is about 100 miles from sea (*see* Fig. 1). Kulkarni[1] established spawning grounds of *Hilsa* in the Narbada river near tidal limits between Nicora and Jhanor villages (about 40 miles from sea), but the spawning activities of *Hilsa* have not hitherto been recorded from freshwater regions of the Narbada river. The present note furnishes evidences collected during summer monsoon seasons of 1959 and 1960, on the spawning of *Hilsa* within freshwater regions of the Narbada river, immediately below Gora, the known uppermost limit of *Hilsa* migration. These observations are of significant importance in view of the construction of the proposed dam across the Narbada near Navagam in Broach district of Gujarat State about 2 miles upstream of Gora.

By operating spawn collection nets in shallow areas of the river during summer monsoon months, approximately 35,000 developing *Hilsa* eggs were collected at Poicha centre from 8-7-1959 to 19-8-1959 and none at Indravarna centre in 1959 season; and about 20,000 *Hilsa* eggs were collected at Poicha from 2-7-1960 to 9-9-1960, about 15,000 eggs at Malsar from 29-7-1960 to 19-9-1960 and 26 eggs at Mangrol from 15-7-1960 to 30-7-1960.

Three batches of *Hilsa* eggs, each numbering 700 to 800, were successfully reared in the field laboratory up to 8, 13 and 14 days after hatching. Descriptions of developmental stages of *Hilsa* agree with the earlier accounts of Kulkarni,[1] and Jones and Menon[2] barring a few differences. Optic vesicles and auditory capsules observed by Kulkarni in newly hatched larva and second-day larva respectively were discerned in the embryonic stages in the present case and as observed by Jones and Menon. According to Kulkarni, and Jones and Menon, the newly hatched larva measured 3·1 mm. and 2·3 mm. respectively but in the present case the average length of newly hatched larva was found to be 2·65 mm. (Range: 2·4–3·0 mm.). The larval stage (measuring 6·5 mm.) with trace of yolk and thickening in dorsal fin region, given by




Jones and Menon, is referable in the present study to the larval stage of tenth day measuring 5·8 mm. On the basis of growth rate in larval stages, Jones and Menon assumed that 8·0 mm. long post-larval stage, with constriction in fin fold behind the dorsal fin, is attained in about

a week but in the present study post-larval stage attained the average length of 6·05 mm. (Range: 5·8–6·2 mm.) in two weeks and did not have constriction behind dorsal fin.

The availability of fertilised eggs and the occurrence of mature *Hilsa* in the commercial catches in the river in 1960 season have shown that the spawning season of *Hilsa* commenced in June-July and continued up to September, the peak of spawning season being in the month of August, when the river was flooded to the maximum (mostly 20′-48′). The observations on the age of developing eggs and the time of their collection indicated that the spawning took place mostly in the afternoon and evening from 2-00 p.m. to 6-00 p.m. The occurrence of *Hilsa* eggs in abundance, which is concomitant with upstream migration of large shoals of *Hilsa*, was found to have relation with lunar periodicities, as the peak collections of *Hilsa* eggs were made during spring tide from 2nd to 4th day and 10th to 12th day after new moon or full moon. The extensive *Hilsa* fishing which was observed in Narbada river on these days also supports this observation. Kulkarni[1] also observed that 'in Narbada river, *Hilsa* is caught on large scale only during spring tide especially from 12th day of each lunar fortnight up to 1st or 2nd day after full moon or new moon'. The observations on the availability of *Hilsa* eggs in relation to fluctuations in water level in the river have shown that when the water level was on the decrease in the upper reaches of the river on 2nd to 4th day and 10th to 12th day after new moon and full moon, the upstream migration and, in consequence, the spawning activities were delayed by few days till the water level in the river began to rise. Jones and Sujansinghani,[3] Chacko and Dixithulu[4] and Kulkarni[5] have also indicated relationships of flood-water with *Hilsa* migration in Chilka lake, Godavari river and Narbada river respectively. The sex ratio in ascending males and females, caught in the vicinity of Broach, was found to be about 3·5 : 1 in the beginning of the spawning season (July) and nearly 1 : 1 during spawning season (August and September). This tends to show that the males ascend to spawning grounds earlier than the females.

The occurrence of large number of developing eggs of *Hilsa* at Malsar and Poicha centres and few at Mangrol centre in 1960 season has indicated that a stretch of 18–20 miles of the river between Poicha and Indravarna constitutes the spawning grounds of *Hilsa* and these observations are in agreement with those of 1959 season. In 1960 season, most of the *Hilsa* eggs collected during morning hours (8–00 a.m. to 11-00 a.m.) at Mangrol, Poicha and Malsar centres were approximately 3, 10 and 19 hours old respectively and few eggs collected during evening hours (2-00 p.m. to 5-00 p.m.) at Malsar centre were 8-10 hours old. The rate of drifting of the eggs along the river bottom has been roughly estimated to be about 1·75 miles per hour, the velocity of surface water being mostly 2 to 5 miles per hour during the period under observation. These observations have pointed out that stray eggs collected at Malsar in the evening hours would have drifted down from minor spawning grounds located in the vicinity of Poicha about 15 miles upstream of Malsar and majority of eggs collected during morning hours at three centres from the main spawning grounds situated few miles below Indravarna in the vicinity of Surejwad fishing village which is about 5, 17 and 33 miles upstream of Mangrol, Poicha and Malsar. These observations are also supported by the fact that the active *Hilsa* fishing was in progress in this area (between Poicha and Indravarna) where *Hilsa* had evidently migrated for spawning. In fact this stretch is reported to be the only regular *Hilsa* fishing area in the freshwater though of minor importance, the other regular fishing centres of major importance being in the tidal area.

The analyses of length-frequency data of *Hilsa* from tidal zone and freshwater zone separately have shown that while all size groups of ripe *Hilsa* (males 265–605 mm.; females 295–605 mm.) occurred in tidal zone, only older *Hilsa* (males 315–485 mm.; females 415–555 mm.) migrated to freshwater areas. It is thus significantly interesting that younger (probably two-year old) ripe *Hilsa* (males 265–315 mm.; females 295–415 mm.), which were encountered in abundance in tidal areas, were totally absent in the freshwater areas, indicating the upstream migration of only older *Hilsa*. The independent observations of Pillay[6] and Jhingran[7] on length frequency of *Hilsa* also point out to long-range upstream migration of only older groups of *Hilsa* in the Gangetic system, as the former recorded the occurrence of ripe males and females in 160–430 mm. and 190–510 mm. size ranges respectively from Hooghly and the latter in 221–465 mm. and 325–485 mm. respectively from Ganga at Buxar (Bihar). From these observations, it appears probable that the younger *Hilsa*, perhaps maturing for the first time, ascend only up to tidal limit whereas the older *Hilsa* migrate higher up in freshwater areas for breeding. Southwell[8] suggested (as

quoted by Sujansinghani[9]) that 'old *Hilsa* probably spawn in the high reaches of the river, while young *Hilsa*, more susceptible to changes involved in the transition from sea to the freshwater, probably spawn lower down the river'. Kulkarni[5] also considered the possibility of differential upstream migration of the younger and the older size groups in Narbada river, but could not decide on the size group which ascends higher up in the river, as no data were available on this aspect.

From length-frequency data of *Hilsa* it is further observed that the largest *Hilsa* specimens, which were present in negligible number in the catches of tidal areas, were not encountered in the freshwater zones. While discussing the upper limit of *Hilsa* migration in Narbada river, Kulkarni[5] stated that the migration of *Hilsa* is curtailed step by step in the stretch of 6–8 miles from Garudeshwar to Makhedi (the uppermost limit) due to swift currents and rapids in that stretch, but some *Hilsa* do cross the barrier at Makhedi. According to him, those *Hilsa* which usually cross this barrier are of larger size. In view of these observations of Kulkarni, it appears probable in the present case that the largest *Hilsa* (males 485–605 mm.; females 555–605 mm.), being comparatively very strong, migrated further up beyond Garudeshwar and were not available in the area of intensive fishing from where the samples were obtained for the present study.

The differential spawning behaviour of two runs of *Hilsa* in Narbada river and elsewhere, the one spawning near tidal limits and the other spawning higher up in freshwater, may be due to either varied nature of physiological changes occurring in the young and the old *Hilsa* or the presence of two different races of *Hilsa*. The morphometric data for the samples from the tidal and the freshwater areas of Narbada river, which are awaiting detailed analysis, are expected to throw light on the latter aspect.

The length-frequency data have further shown that as compared to Gangetic *Hilsa*, the Narbada *Hilsa* attains first maturity at higher length (265 mm. ♂ and 295 mm. ♀) and is also of larger size (over 605 mm., both ♂ and ♀). The size variations in *Hilsa* stocks of Gangetic system and Narbada river may be entirely due to differences in the biological environments. The comparison of morphological characters of Narbada *Hilsa* with those of Gangetic *Hilsa* should throw light on this aspect of *Hilsa* stocks of the two river systems.

My grateful thanks are due to Dr. B. S. Bhimachar, Director and Dr. M. P. Motwani, Research Officer of Central Inland Fisheries Research Institute, for their valuable suggestions and constant encouragement and to Sarvashri M. D. Pisolkar, P. Das and P. K. Pandit of Narbada-Tapti Unit for their ungrudging assistance in the field.

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## AEROSOL LAYER IN THE STRATOSPHERE

STUDIES of nuclear fall-out distribution in the upper atmosphere caried out by analysis of air samples collected by high altitude balloons and aircrafts, have shown that there is present an aerosol layer 3 miles thick, consisting mainly of sulphur particles, enveloping the earth about 11 miles out in space. In analyzing the samples it was noticed that the concentration of sulphur was exceptionally large between altitudes of 11 and 14 miles. Detailed studies during the year undertaken by the Air Force Cambridge Research Laboratories U.S.A. have shown that the concentration of particles within the layer is about 16 per cubic inch which is three times the number at adjacent levels. These particles are between 0·1 and 2 microns in size. Electron microprobe analyses of samples showed the layer is about 85% sulphur. Silicon, iron and aluminium were also found in some samples.

The aerosol layer is thought to originate at its observed location. Probably gases such as hydrogen sulphide or sulphur dioxide known to be present at lower altitudes, enter the stratosphere and are chemically changed either by sunlight or ozone.

The world-wide aerosol layer may at last provide an explanation for the twilight phenomenon known as purple light. This conspicuous red disk of light is frequently seen above the point of sunset or sunrise. A thick aerosol layer in the stratosphere could scatter light in such a way to produce just the phenomenon.—(*J. Frank. Inst.*, 1961, 272, 84.)

# LETTERS TO THE EDITOR

## STUDY OF ASTRAL MOLECULES: INTENSITIES, FRANCK-CONDON FACTORS AND $r$-CENTROIDS OF THE BANDS OF BaO ($^1\Sigma$–$^1\Sigma$) SYSTEM

QUANTITATIVE gross intensity study of the bands of BaO ( $^1\Sigma$–$^1\Sigma$ ) system excited in a flame from a specially designed burner has been made by rigorous methods of photographic photometry in the general programme outlined for the investigations of astral molecules in this laboratory. The results of intensities obtained by evaluating the area under the intensity contours of bands after the manner of Tawde and Patankar[1] and Tawde and Sreedhara Murthy[2] are entered in Table I for the system.

TABLE I

*Integrated intensities*
*BaO ($^1\Sigma$–$^1\Sigma$) system*

| Band $v', v''$ | Intensity | Band $v', v''$ | Intensity |
|---|---|---|---|
| 0, 0 | 9·48 | 2, 0 | 54·3 |
| 0, 1 | 11·9 | 2, 1 | 100 |
| 0, 2 | 77·3 | 2, 2 | 17·4 |
| 1, 0 | 22·5 | 3, 0 | 54·4 |
| 1, 1 | 94·4 | 3, 1 | 30·7 |
| 1, 2 | 94·2 | 3, 3 | 31·8 |
| | | 3, 4 | 12·9 |

These intensities have been used to arrive at the experimental Franck-Condon factors ($I/\nu^4$). The same have been computed theoretically by (*a*) Manneback's method under harmonic oscillator concepts and by (*b*) Bates' method of numerical integration, involving anharmonic oscillations. Comparative study of the results of the two theoretical methods between themselves and in relation to experimental data has been made. It gives better agreement of experimental results with the latter theory (*b*), as is to be expected.

Further, the data of the above numerical integration method of Bates has been compared with the recent theoretical computations of Ortenberg[3] by (*i*) Bates' tabular method; (*ii*) Morse's simplified potential method and (*iii*) the method of $r_e$-shift. All these values have been found to be more or less in agreement among themselves. One expects, however, the results of numerical integration to be better representative of the transition probabilities.

The theoretical transition probabilities as obtained by Bates' numerical integration method have been further subjected to correction for the variation in electronic transition moment with internuclear distance. For this purpose, the $r$-centroids have been calculated by two methods, *viz.*, (*i*) the direct method and (*ii*) the mean value method, given by Nicholls and Jarmain.[4] Of these two methods, the results of the direct method are justified to be more accurate.

Using the above $r$-centroid values and the Franck-Condon factors as evaluated by Bates' method, the relation between $R_e(r)$, the electronic transition moment and $r$, the internuclear distance has been evolved according to the several procedures suggested by Nicholls[5] and Turner and Nicholls.[6] For the system of BaO under investigation, the relation takes the form

$$R_e(r) = \text{Const.}\ (1 - 0{\cdot}536\, r).$$

With this relation, the final smoothed transition probabilities have been derived. It is concluded that the degree of agreement between theory and experiment becomes double on introduction of anharmonicity into harmonic oscillator concepts and five times when anharmonic oscillations are further corrected for electronic moment variation. This establishes the significance of the latter in the concepts of the theories of vibrational transition probabilities.

The detailed results of this investigation are being reported elsewhere in the form of a full paper.

The author records his gratefulness to Dr. N. R. Tawde, the Head of the Department of Physics, for suggesting the problem and for his constant guidance.

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## POTENTIAL CONSTANTS AND THERMODYNAMIC PROPERTIES OF $SiBr_3I$

THE molecules of the type $XY_3Z$ whose normal vibrations have been studied by Meister and Cleveland[1] on the basis of Wilson's group theoretical method,[2] have the symmetry point group $C_{3v}$ and on the application of relevant selection rules[3] give rise to three non-degenerate $A_1$ type vibrations and three degenerate E type vibrations. All are allowed both in Raman as well as infra-red absorption spectra.

The fundamental frequencies of $SiBr_3I$ studied by Dalwaulle and her co-workers[4] occur at 120 cm.$^{-1}$ ($A_1$), 225 cm.$^{-1}$ (A ), 443 cm.$^{-1}$ ($A_1$), 79 cm.$^{-1}$ (E), 127 cm.$^{-1}$ (E) and 487 cm.$^{-1}$ (E). Using these frequencies in cm.$^{-1}$, considering the bond distances Si-I = 2·45 Å and Si-Br = 2·19 Å and assuming all the angles as tetrahedral, the potential constants on the basis of Wilson's group theoretical method have been calculated. Some of the interaction constants are borrowed from the related molecules and the values of other constants are systematically adjusted so that the obtained force constants reproduce the observed fundamental frequencies to the nearest wave number. The values of the constants in $10^5$ dynes per cm. are given below:

$f_D = 2{\cdot}0113$; $f_d = 2{\cdot}4257$; $f_{rd} = 0{\cdot}2832$; $f_{dd} = 0{\cdot}1534$; $f_{d\theta} = 0{\cdot}1522$; $f_{d\phi} = 0{\cdot}2614$; $f_\theta - f_{\theta\theta} = 0{\cdot}2025$; $f_\phi - f_{\phi\phi} = 0{\cdot}1533$; $f_{D\theta} + f_{D\phi} = 0{\cdot}1038$; $f_{\theta\theta} + f_{\phi\phi} = -0{\cdot}0515$ and $f_\theta + f_\phi = 0{\cdot}3043$.

Using the above fundamental frequencies in cm.$^{-1}$ of $SiBr_3I$, the thermodynamic properties such as heat content, free energy, entropy and heat capacity were calculated for the temperature range from 50° to 1,600° K. A rigid rotator, harmonic oscillator model was assumed and the values were calculated for the ideal gaseous state at one atmospheric pressure. Using the above parameters the moments of inertia calculated are given below:

$I_{xx} = I_{yy} = 1255{\cdot}9636$ AWU Å$^2$
$(2086{\cdot}3188 \times 10^{-40}$ g. cm.$^2)$

$I_{zz} = 1022{\cdot}1576$ AWU Å$^2$
$(1697{\cdot}9367 \times 10^{-40}$ g. cm.$^2)$

The symmetry number is 3. The values obtained for the thermodynamic properties of $SiBr_3I$ are given in Table I.

The author wishes to express his grateful thanks to Dr. K. Venkateswarlu for his constant encouragement and interest during the progress of this work, and to the University Grants Commission, Government of India, for the award of a post-graduate research scholarship.

TABLE I

*Heat content, free energy, entropy and heat capacity of $SiBr_3I$ for the ideal gaseous state at one atmospheric pressure**

| T (°K.) | $(H_0 - E_0°)/T$ | $-(F_0 - E_0°)/T$ | S° | $C_p°$ |
|---|---|---|---|---|
| 50 | 9·617 | 54·002 | 63·619 | 12·960 |
| 100 | 12·519 | 61·606 | 74·125 | 17·306 |
| 150 | 14·547 | 67·087 | 81·634 | 19·753 |
| 200 | 16·085 | 71·507 | 87·592 | 21·468 |
| 273·16 | 17·747 | 76·747 | 94·494 | 23·036 |
| 298·16 | 18·213 | 78·369 | 96·582 | 23·393 |
| 300 | 18·233 | 78·436 | 96·669 | 23·415 |
| 400 | 19·673 | 83·957 | 103·630 | 24·354 |
| 500 | 20·642 | 87·379 | 108·021 | 24·843 |
| 600 | 21·384 | 92·256 | 113·640 | 25·127 |
| 700 | 21·936 | 95·649 | 117·585 | 25·309 |
| 800 | 22·352 | 98·548 | 120·900 | 25·423 |
| 900 | 22·701 | 101·157 | 123·858 | 25·508 |
| 1000 | 23·005 | 103·834 | 126·839 | 25·570 |
| 1100 | 23·220 | 105·829 | 129·049 | 25·612 |
| 1200 | 23·450 | 108·066 | 131·616 | 25·650 |
| 1300 | 23·594 | 109·658 | 133·252 | 25·674 |
| 1400 | 23·751 | 111 599 | 135·350 | 25·696 |
| 1500 | 23·863 | 113·284 | 137·147 | 25·712 |
| 1600 | 23·998 | 114·828 | 138·826 | 25·727 |

* T is the temperature in degrees Kelvin, the other quantities are in cal. deg.$^{-1}$ mole$^{-1}$ and $E_0°$ is the energy of one mole of perfect gas at absolute zero temperature.

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## EVALUATION OF THE DIAMAGNETIC ANISOTROPY OF BENZENE FROM THE SUSCEPTIBILITIES OF SOME CARBOCYCLIC COMPOUNDS

CYCLOHEXANE, cyclohexene, cyclohexadiene, and benzene form a regular sequence of carbocyclic compounds with six carbon atoms in the ring. The second, the third and the fourth members of this sequence may be considered to be obtained from the one preceding these, by the removal of two hydrogen atoms and the conversion of one C—C bond into a C = C linkage. This regular step-wise change in the structure may be expected to be reflected in the magnetic properties of these compounds and the gram-

molecular susceptibilities ($\chi_M$) ought to show corresponding regular variations. These susceptibilities are given in Table I, for comparison. The values have been taken from Pascal's work quoted in *International Critical Tables*. Although the recent accepted value of $\chi_M$ for benzene is slightly lower than the one given here, it is not being used because similar revised data on the other substances are not available. It is felt, however, that the arguments being presented in this note will remain unaffected by a revision of these values.

TABLE I

*Values of the diamagnetic susceptibilities of some carbocyclic compounds*

| | $-\chi \times 10^6$ | $-\chi_M \times 10^6$ | $-\Delta\chi_M \times 10^6$ |
|---|---|---|---|
| Cyclohexane | 0·810 | 68·18 | 9·79 |
| Cyclohexene | 0·711 | 58·39 | |
| 1 : 3 Cyclohexadiene | 0·607 | 48·67* | 9·72 |
| 1 : 4 Cyclohexadiene | 0·608 | | |
| Benzene | 0·712 | 55·67 | |

* Mean of the two values for 1 : 3 and 1 : 4 cyclohexadienes.

It can be seen from the values given in Table I that the numerical decrease in the value of $\chi_M$ in going from the first to the second and from the second to the third compound is almost the same and the mean value of these two decrements is 9·76 units. If this reduction is associated with the change in the structure, namely, removal of two hydrogen atoms and the conversion of one C—C bond into a C = C linkage the gram molecular susceptibility of benzene should be expected to be $-38{\cdot}91 \times 10^{-6}$. The observed value is numerically larger than this by $16{\cdot}76 \times 10^{-6}$. The only reason for this enhanced diamagnetism appears to be the presence of alternate single and double bonds between the carbon atoms of the ring, resulting in the complete delocalization of the $\pi$ electrons. It is an accepted fact[1] that these $\pi$ electrons are responsible for the high diamagnetic anisotropy of the benzene molecule. The point of present interest, therefore, is the conclusion that the contribution of the $\pi$ electronic ring orbits to the susceptibility of liquid benzene is $-16{\cdot}76 \times 10^{-6}$ and that the remaining part of the observed value of $\chi_M$, i.e., $-38{\cdot}91 \times 10^{-6}$, is due to the rest of the molecule. If it is assumed that the anisotropy is entirely due to the ring orbits, then the contribution of the rest of the molecule can be considered to be isotropic. This leads to the result that the molecular susceptibilities ($K_1$ and $K_2$) in the plane of the ring should be equal to $-38{\cdot}91 \times 10^{-6}$. Again, since $\chi_{ave} = K_{ave} = 1/3 \quad (K_1 + K_2 + K_3)^2$, the diamagnetic anisotropy, $\Delta K\ (= K_3 - K_1)$ comes out to be $-50{\cdot}28 \times 10^{-6}$.

The values of the principal molecular susceptibilities of benzene and the anisotropy evaluated above are given in Table II for comparison with the results from other sources.

TABLE II

*Principal molecular susceptibilities and the diamagnetic anisotropy of benzene*

| | Present work | Pauling[3] | Krishnan, Guha and Banerjee[4] |
|---|---|---|---|
| $-K_1 (= K_2) . 10^6$ | 38·91 | 39 | 37·3 |
| $-K_3 . 10^6$ | 89·19 | 88·2 | 91·2 |
| $-\Delta K . 10^6$ | 50·28 | 49·2 | 53·9 |

It will be observed that the results of the present evaluation are in good agreement with the theoretical values obtained by Fauling[3] and also with the estimates of Krishnan, Guha and Banerjee[4] obtained from the magnetic birefringence and light-scattering data.

It is possible to evaluate the radius of the benzene ring with the help of Langevin's theory of diamagnetism and the value of $\Delta K$. Adapted to this case, the theory gives

$$\Delta K = -\frac{Ne^2}{4mc^2}\sum_n r^2 = -4{\cdot}248\ nr^2 \times 10^{16}.$$

Here, the symbols have their usual meanings and $n$ is the number of $\pi$ electrons in the molecule. Taking $n = 6$ and $\Delta K = -50{\cdot}28 \times 10^{-6}$, the value of '$r$' comes out as 1·405 Å. This value of the radius of benzene ring compares nicely with the accepted value of the C—C distance, $1{\cdot}39 \pm 0{\cdot}02$ Å, of this molecule.[5]

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## STACKING FAULTS IN A GOLD-CADMIUM ALLOY ($Au_{80}Cd_{20}$)

THE incidence of deformation stacking faults on cold working metals and alloys with close-packed crystal structures has frequently been investigated in the recent past.[1] The data available so far seem to suggest that the fault parameter ($\alpha$) defined as the probability of finding a deformation fault on any close-packed plane may be large for metals and alloys which undergo a phase transformation from the face-centred cubic (f.c.c.) to the hexagonal close-packed (h.c.p.) structure on cooling or heating and hence have nearly the same free energies for these two structures at room temperature. This suggestion has been supported by work on h.c.p. cobalt[2] and cobalt-nickel alloys.[3] A fault parameter of 0·075 was obtained for filings of pure cobalt which undergoes the f.c.c.-h.c.p. transformation martensitically from about 420° C. on cooling. This value was found to increase to 0·145 for a cobalt-22% nickel alloy having a lower phase transformation temperature than cobalt.

High stacking fault densities as above have not been measured for any f.c.c. structure in the deformed state. Oscillation photographs of a cold-worked copper-10% silicon alloy seem to suggest heavy faulting in the f.c.c. phase which transforms to the h.c.p. structure by a nucleation-and-growth mechanism at about 650° C. on slow cooling, but remains untransformed on rapid cooling.[4] Considerable broadening of X-ray reflections has also been observed and attributed to stacking faults in several f.c.c. as well as h.c.p. gold-cadmium alloys.[5–7] There is need, however, for quantitative experimental work on alloys undergoing the f.c.c.-h.c.p. transformation on slow cooling and capable of existence in the f.c.c. phase on rapid cooling to room temperature. Hence a detailed study of some selected alloys, *e.g.*, gold-20% cadmium, silver-11% tin and the afore-mentioned copper-10% silicon, was started by us recently. The aim of our investigations is not only to check whether the expected high density of stacking faults is actually observed in fresh filings of these alloys, but also to confirm whether the fault parameter varies markedly with the extent of deformation as reported earlier for brass filings.[8]

We examined sieved filings of the $Au_{80}Cd_{20}$ alloy in the cold-worked and annealed conditions by taking Debye-Scherrer patterns with Cu $K_\alpha$ radiation in the Nonius-Guinier camera with a bent crystal monochromator and obtaining profiles of the 111- and 200-reflections through a Joyce automatic recording microdensitometer. As expected, the reflections from the cold-worked alloy displayed marked broadening as also a striking shift of the peaks in opposite directions (Fig. 1). The deformation fault parameter ($\alpha$) was determined by measuring the change in separation in degrees between the peaks of the two reflections from the annealed to the deformed state using the equation[9]

$$\triangle 2\theta = \frac{\pm \tan\theta \cdot \cos^2\phi \cdot 270\sqrt{3} \cdot \alpha}{\pi^2 \cdot h_3},$$

where $\triangle 2\theta$ is the shift in peak for the $hkl$-reflection, $\phi$ is the angle between the reflecting normal and planes containing deformation faults and $h_3$ is $|h+k+l|$. Fresh filings having a grain size lower than 0·06 mm. were found to have a fault parameter of 0·087, *i.e.*, one stacking fault on the average for every 12 close-packed planes. This represents the highest stacking fault density so far recorded for a deformed f.c.c. structure.

The profile of the 111-reflection for the fresh filings (Fig. 1) shows a prominent step at a lower angle which is identical with the Bragg angle of the $10\bar{1}0$-reflection of the corresponding h.c.p. structure. This has been predicted[7] for high stacking fault densities as the broadening in the L direction in the common reciprocal lattice for f.c.c. and h.c.p. structures has to end at zero L value for this reflection.

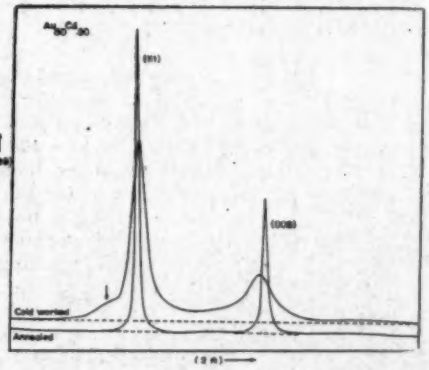


FIG. 1. Photometric record of the 111- and 200-Debye–Scherrer reflections for a gold-20% cadmium alloy in the annealed and cold-worked states (Nonius-Guinier camera; Cu $K_\alpha$ X-radiation).

For filings of a large grain size, *viz.*, > 0·22 mm., the X-ray line broadening was definitely less and the faulting parameter was only 0·060. This result confirms the earlier

observation on brass filings. The difference between the two recorded fault parameters, *viz.*, 0·087 and 0·060, is large enough to indicate a definite contribution of inhomogeneous distribution of stacking faults in filings of mixed grain size to any observed asymmetry of line profiles. This fact should not be ignored in attributing any such asymmetry in line profiles to the formation of growth or twin stacking faults as well on deformation.[10]

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## PHOTOLYTIC PREPARATION OF URANIUM (IV) SULPHATE COMPLEXES

GREEN compounds are obtained when photolysis of uranyl ion in presence of ammonium sulphate and alcohol is carried out in sunlight. These products being highly soluble are different from uranium (IV) oxysulphate $UOSO_4$ obtained by the same method reported earlier.[1] This behaviour suggested clue to the formation of complex compounds of uranium (IV) oxy sulphate with ammonium sulphate. The moist compounds have been used for the analyses of the constituents, namely total uranium, uranium (IV), ammonium and sulphate contents, according to standard methods.

The compound obtained by the photolysis of uranyl sulphate and ammonium sulphate taken in the ratio of 1 : 8 is found to contain $U^{4+}$, $NH_4^+$, and $SO_4^{2-}$ in the ratio of 1·00 : 1·50 : 1·75. So the compound has been assigned the formula $2UOSO_4$, 1·5 $(NH_4)_2SO_4$, $nH_2O$. However, a different compound is formed when photolysis is carried out with uranium and ammonium sulphate in the ratio of 1 : 16. On analysis, $U^{4+}$, $NH_4^+$ and $SO_4^{2-}$ have been found to be present in the ratio of 1·00 : 2·00 : 2·00, so the formula $UOSO_4$, $(NH_4)_2SO_4$, $nH_2O$ has been assigned to this complex.

Sodium and potassium complexes have been prepared by the same method of photolysis. The compound $UOSO_4$, 0·75 $Na_2SO_4$ $nH_2O$ is obtained when the ratio of uranylsulphate to sodium sulphate is 1 : 4, but with the ratios of 1 : 8, 1 : 12 and 1 : 16, the complex $UOSO_4$, $Na_2SO_4$ $nH_2O$ is isolated. Two potassium complexes, namely $UOSO_4$, $K_2SO_4$, $nH_2O$ and $UOSO_4$, 1·75 $K_2SO_4$ $nH_2O$ have been prepared when uranylsulphate and potassium sulphate are taken in the ratio of 1 : 8 and 1 : 12 respectively.

Attempts for preparing these compounds by conventional methods such as crystallisation and solvent exchange proved unsuccessful.

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## STUDY OF THE REACTION OF MANDELIC ACID WITH SODIUM MOLYBDATE AND SODIUM TUNGSTATE

MANDELIC acid has been known to be used for the detection of certain elements like copper.[1] A survey of the literature has shown meagre references wherein mandelic acid has been used as a complexing agent. The authors have, therefore, taken up the reaction of mandelic acid with sodium molybdate and sodium tungstate with a view to ascertaining their stoichiometric ratio by using physico-chemical methods like pH and conductance.

All the reagents employed were of B. D. H. Analar variety. Sodium molybdate and sodium tungstate were analysed by the usual methods and the analyses established their formulæ as $Na_2MoO_42H_2O$ and $Na_2WO_42H_2O$ respectively. Various solutions were prepared by dissolving them in double distilled water. Doran's conductivity bridge with a WTW oscillator was used for conductance measurements and Beckmann pH meter model G-2 with standard calomel and glass electrode was used for the pH measurements. The temperature of all the solutions was maintained at $28 \pm 0·1°$ C.

To arrive at the stoichiometry, the monovariation method[2] was used. This method was utilised in the following way. To 5 ml. of sodium molybdate and sodium tungstate varying amounts

of mandelic acid were added and the total volume was always made up to 30 ml. with distilled water. The solutions were left for about twelve hours to attain equilibrium. Conductivity and pH of the solutions were then measured for various concentrations of all the solutions. Taking conductance or pH as abscissa and the amount of ligand used as ordinate graphs were plotted. In all the cases a clear break is obtained which corresponds to the ratio 1 : 2.

Hence it is found that both sodium molybdate and sodium tungstate form a 1 : 2 complex with mandelic acid. This was further confirmed by Job's method of continuous variation.[3,4] Three different compositions of all the solutions, *viz.*, M/80, M/100 and M/120 were used. Blank experiments under similar conditions were performed with the metal solution and ligand solution separately. The divergence from the additivity rule was plotted against the composition and the maxima in all the cases correspond to 0·66. This firmly establishes the stoichiometry of both the complexes at 1 : 2.

The authors express their gratitude to Prof. A. K. Bhattacharya for his keen interest evinced in the present work and to the U.G.C. for awarding a research scholarship to one of them (S.P.B.).

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## ORGANIC ACID METABOLISM IN TAMARIND LEAVES

The only organic acids in the leaves and fruits of the tamarind tree are the optically active d-tartaric and l-malic acids.[1] The seasonal variation of tartaric acid in tamarind leaves has been reported by us earlier[2]; the studies have now been extended to l-malic acid also. Leaf sap, instead of whole leaves, was used this time, since this is recommended to give a composite sample representative of the solution of total soluble organic acids in the normal living system.[3] The studies on seasonal variation of the acids in the leaf sap and a few metabolic experiments on isolated leaves reported here indicate that the acids synthesised in the leaves are primarily translocated to the growing berries, with little or no metabolic utilization.

Leaf sap was prepared by grinding freshly plucked leaves in a triple-roller mill and then pressing in a carver press. Aliquots of the clear juice obtained on centrifugation of the extract were used for determination of d-tartaric and l-malic acids according to methods[4] based on A.O.A.C. procedures for these acids in fruit juices.[5] All samples of leaves were taken from a healthy tree in the Institute premises.

The changes in acid concentration in the leaf sap from April through March are graphically shown in Fig. 1. The preponderance of tartaric over malic acid almost throughout the year is obvious; only towards the end, in winter, the malic acid content becomes comparable to that of tartaric acid. There is a gradual rise in the pH of the sap from 2·3 to 4·1 as the tartaric acid content decreases. An additional reason for this shift in pH is the absorption of calcium and potassium which partially neutralise the acids forming acid salts.[2] A major portion of the acid tartarates remains behind fixed in the leaves because of low solubility.

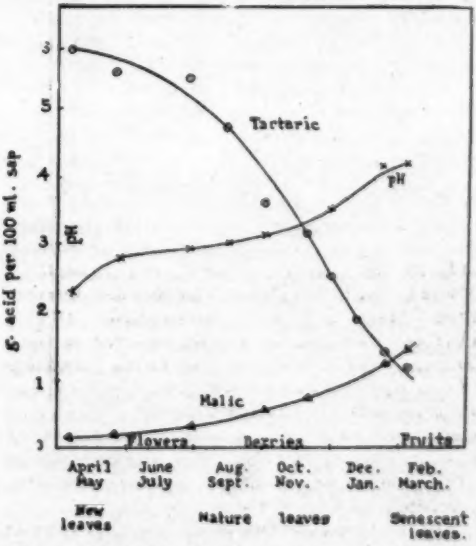


FIG. 1. Seasonal variation in pH and tartaric and malic acid content of tamarind leaf sap. The progressive appearance of flowers, berries and fruits on the one hand and new leaves, mature leaves and senescent leaves on the other are indicated along the horizontal axis at the corresponding months of the year.

Analysis of leaves picked early in the morning and late in the evening at three different parts of the year did not show any significant change

in tartaric or malic acid content between morning and evening in a single day. This indicates the absence of any 'Crassulacean' type of metabolism.

Starvation experiments with excise leaves according to the technique of Pucher *et al.*[6] did not show any change in tartaric acid content even after 72 hours. However, a slight decrease in malic acid was observed.

Respiratory quotients of leaves and flowers were determined using a simple eudiometric type respiroscope (Ganong respiroscope). The values for flowers approached unity (0·95) which is typical of many plants, but those for samples of leaves were abnormally low (0·75–0·78). Oxidation of malic and tartaric acids would result in R.Qs far greater than 1 (1·3–1·6).

Studies by Stafford and Loewus[7] on grape leaf indicate that tartaric acid is formed in a secondary process from the primary carbohydrate products of photosynthesis. Fresh bright green foliage and long hours of sunlight in the summer are ideal for photosynthetic processes in the tamarind tree. The accumulation of large amounts of tartaric acid in the leaf sap during this season is very significant. The metabolic conversion of α-glucose to tartaric acid by removal of carbon atoms 5 and 6 and oxidation to dicarboxylic acid is suggested by Vickery and Palmer.[8] Since oxaloacetate was found to be sluggishly oxidised by young tamarind leaves in respiratory studies, Ramakrishnan and Joshi[9] have suggested that sugar gets converted to oxaloacetate through the operation of the tricarboxylic cycle enzymes and that oxaloacetate gets converted to tartrate *via* hydroxyfumarate. Whatever be the mechanism of such conversions, tartaric acid once formed cannot enter back into the metabolic cycle. The only known enzymes in higher plants which metabolise tartaric acid do not use the (+) isomer.[7]

That the origin of malic acid may be different from that of tartaric acid is indicated by the fact that, unlike tartaric acid, its concentration is very low in the new leaves and becomes comparable to tartaric acid only towards the end of the year. It is well known that the formation of malic acid by $CO_2$ fixation is optimal at low temperature and the observation, that the malic acid content of tamarind leaves becomes appreciable only in winter months is significant in this context.

The absence of any diurnal variation, the non-utilization of acids during starvation and low respiratory quotients all indicate little or no metabolic utilization of tartaric and malic acids in the leaves, once they are formed. Translocation to the growing berries and fixation in the form of insoluble tartrates in older leaves account for most of the acids produced. The accumulation of acid to a high concentration at any stage only implies that the rate of production is higher than the rate of withdrawal.

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## SEWAGE AND ACTIVATED SLUDGE AS CONVENIENT SOURCES FOR THE ISOLATION OF *AZOTOBACTER AGILIS*

Because of their role in the nitrogen economy of nature, *Azotobacter* species have received considerable attention with regard to their habitat and distribution. Bergey's Manual[1] seeks to recognize only three species, *viz.*, *A. chroococcum*, *A. agilis* and *A. indicus* and refers to their habitat as respectively soils, water and soil, and soils. However, there is enough justification to conclude that there exist other species, *e.g.*, *A. insigne*, whose presence in water has been revealed during recent years.[2,3] Thus it would appear that the distribution of *Azotobacter* species in nature is restricted more or less to soil and water.

The reported presence of *A. agilis* in sewage by Soriano[4] and in strawboard waste water by Smit[5] and Johnstone[6] is of special interest in this connection, but unfortunately, Soriano's observation was limited to the isolation of only one strain. With a view, therefore, to see whether its isolation from sewage was a chance finding, enrichments were set up for isolating *Azotobacter* from sewage and activated sludge. It is of interest to mention here that activated

sludge is relatively rich in nitrogen and the presence of this bacterium therein or in sewage would not only help explain its possible role in the nitrogen status of the sludge but also in gaining an insight into the ecology of this organism.

For isolation purposes, an enrichment medium containing 0·5% each of sucrose and mannitol as carbon source was employed and was inoculated with either 1 ml. sewage or activated sludge. Details of the isolation procedure have been presented elsewhere.[7] Examination of 21 samples of raw sewage and 9 samples of sludge resulted in the isolation of 24 cultures of *Azotobacter* of which 3 were characterized as strains of *A. chroococcum* and the remaining 21 as those of *A. agilis*. The recognition of *A. agilis* was based *inter alia* on the fact that they had peritrichous flagella, did not produce cysts and did not utilise mannitol. All the strains produced a green pigment when the medium contained suboptimal amounts of iron, but not when its adequacy was maintained in the medium. This is in conformity with past observations on *A. agilis*,[8,9] though it must be pointed out here that the change in the colour of the pigment from green to violet has not been recorded before except by Schutter and Wilson.[8] It is also of some interest to observe that flagellar stained preparations not infrequently revealed a tuft of flagella, a characteristic associated with *A. insigne*. Nevertheless we have referred to the flagellation as peritrichous as many of the cells did show a flagellar pattern that could be frankly recognised as such.

Whether the identity established for the dominant sewage *Azotobacter* be *A. agilis* or *A. insigne* is of lesser interest here when compared to the significance that must be attached to its occurrence therein. For, though sewage comprises of soil washings, only 3 cultures of *A. chroococcum* were isolated and no other soil forms were encountered. That this was not caused by the unsuitability of our medium was judged by the fact that the same medium, inoculated with soils, had resulted in the exclusive isolation of *A. chroococcum*; and, it was precisely for the enrichment of this species that a sucrose-mannitol medium was employed in all the experiments notwithstanding the observation that *A. agilis* was unable to use mannitol. Apparently, therefore, the former species is not suited to an aquatic nidus, while the latter finds even a highly polluted aquatic environment suitable. That *A. agilis* is able to survive against the legion of other bacteria in an environ of this type is in itself interesting and reveals a new source for its ready isolation, not to mention the ecological implications of the finding under report.

The authors' thanks are due to Dr. S. C. Pillai and Dr. S. Bhagavantam of this Institute for their keen interest.

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Indian Institute of Science, J. V. Bhat.
Bangalore, *September* 4, 1961.

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## ACETIC FERMENTATION OF MOLASSES

The work outlined below formed part of the experiments done by the author on the production of acetic acid from molasses. On the same subject H. D. Sen in recent years had earlier published some work.[1,2] The object here is to record some salient findings in connection with the acetic fermentation of molasses.

The procedure of the experiments briefly was as follows. Molasses solution of 20° Bx was clarified by boiling with lime and superphosphate. The clear, cooled solution was fermented with a pure culture of distillery yeast and at the end of fermentation the alcoholic wash was allowed to settle and become clear.

The culture of acetic bacteria was derived from the spontaneous fermentation of cane juice and worked in two acetifiers, one a 6-gallon wooden vessel and another a 45-gallon wooden cask, on the principle of the Quick Vinegar Process. In each of the acetifiers a middle zone between two perforated wooden discs, filled with wood shavings, formed the culture bed for the bacteria. The alcoholic wash was operated at 6 litres in the small acetifier and 15 gallons in the cask acetifier, mixed with a third of its volume of previously acetified wash. During the circulation of the wash air from the laboratory compressor was admitted at a suitable rate into the chamber below the lower perforated disc. Ammonium sulphate was the only

nutrient employed. The acetifying wash, finding its way out, was collected and returned to the feeding tubs three times a day, and the feeding was so regulated that the wash undergoing acetification in each acetifier circulated through it once a day.

The results of a few of the experiments done are summarised in Table I. They indicate the following features.

TABLE I

| Expt. No. in the acetifier | Quantity of alcoholic molasses wash taken | Acetified wash added | Water added | g. absolute alcohol per 100 c.c. in the alcoholic wash taken | g. ammonium sulphate | Period of acetification, days | Initial acidity, g. acetic acid per 100 c.c. total volume | Final acidity, g. acetic acid per 100 c.c. final volume | % Theoretical yield realised |
|---|---|---|---|---|---|---|---|---|---|
| *Small acetifier* | | | | | | | | | |
| 34 | 6 litres | 2 litres | .. | 5·66 | 3 | 8 | 1·80 | 5·85 | 66·3 |
| 35 | ,, | ,, | .. | 6·31 | Nil | 9 | 1·83 | 6·24 | 65·7 |
| 36 | 8 litres | Nil | .. | 6·37 | ,, | 5 | 0·69 | 2·82 | .. |
| 37 | 6 litres | 2 litres | .. | 6·37 | 3 | 12 | 2·04 | 6·06 | 53·0 |
| 38 | ,, | ,, | 2 litres | 6·59 | 3 | 8 | 1·62 | 5·70 | 73·5 |
| 39 | ,, | ,, | ,, | 6·59 | 3 | 6 | 1·56 | 5·52 | 73·3 |
| *Cask acetifier* | | | | | | | | | |
| 4 | 15 gls. | 5 gls. | .. | 5·10 | 68 | 8 | 1·65 | 4·95 | 51·3 |
| 5 | ,, | ,, | .. | 5·20 | 68 | 10 | 1·80 | 5·22 | 54·4 |
| 6 | ,, | ,, | .. | 5·20 | 34 | 9 | 2·04 | 5·52 | 57·5 |
| 7 | ,, | ,, | .. | 5·62 | Nil | 12 | 1·68 | 5·82 | 62·2 |
| 8 | ,, | ,, | .. | 6·24 | 34 | 13 | 1·86 | 6·36 | 60·8 |
| 9 | ,, | ,, | .. | 6·31 | 34 | 14 | 2·04 | 6·36 | 57·2 |
| 10 | ,, | ,, | .. | 6·31 | 34 | 16 | 2·04 | 6·69 | 62·4 |
| 11 | ,, | ,, | 2 gls. | 6·48 | 34 | 11 | 1·92 | 6·42 | 69·6 |

The final acidity reached in the wash equalled 5 to 6 g. acetic acid per 100 c.c., according to the alcoholic content of the molasses wash.

The period of acetification was considerably reduced on working the wash with water (*vide* experiments 38 and 39 in the small acetifier and experiment 11 in the cask acetifier). This points to the advantage of working diluted wash when delays occur in acetification.

When acetified wash was not used with the alcoholic wash (*vide* experiment 36), there was a set-back in acetification which therefore was incomplete, with some adverse consequences on the next experiment also. Acetified wash, when employed, served to dilute the alcohol concentration and hasten the acetification, while giving immunity to the culture by virtue of its acidity.

The net production of acetic acid in the wash, taking into account the initial and final volumes and the initial and final acid concentrations, worked out to 65% of the theoretical yield possible from the alcohol. Working diluted wash stimulated the activity of the bacteria and definitely increased the percentage yield. The yield thus rose to 73% in experiments 38 and 39 of the small acetifier and to 69·6% in experiment 11 of the cask acetifier. In the latter acetifier the results in general were subject to some absorption losses and inadvertent leaks.

From a ton of molasses yielding 100 gallons of proof spirit or 57 gallons (*i.e.*, 452 lb.) of absolute alcohol, at least 354 lb. (60% yield) of acetic acid may be estimated to be produced in the wash. The distillation and purification of the acetic acid are a different question. The acetified wash from good quality molasses, producible at about 800 gallons per ton, is hoped to serve as cheap vinegar.

The author thanks Messrs. Parry and Co., Ltd., for giving him opportunity to carry out the experiments.

Masulipatam, *August* 30, 1961. B. G. KRISHNAMURTI.

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## HEAVY ACCESSORY STUDY OF THE SANDS OF CAPE COMORIN

THIS note reports the results of a preliminary study of the heavy mineral assemblage of the sands collected from the beach sands of Cape Comorin, Madras State. A tract of nearly seven miles, extending from Nagercoil up to Cape Comorin, along the beach is found enriched in mineralised sands. The minerals occurring in

the sands are mostly, ilmenite, monazite, zircon and garnet.

Systematic sampling was made from the off-shore, seaward up to the low-tide mark and the samples collected were mostly bulk samples. As the sands show a remarkable variation in the direction of the slope of the shore, the above method of collecting bulk samples was resorted. Six representative bulk samples were collected for the purpose of heavy mineral study. The study includes heavy mineral analysis, shape and size analysis.

### Heavy Mineral Study

The method is mainly modelled on the lines suggested by Grooves.[1] The six samples chosen for the study of heavy minerals cover a wide range of mineral composition and coarseness. The mounting of heavy crop separated by bromoform for microscopic study was done in methyline iodide of refractive index 1·74, after the method of Tatarsky.[2] Counts of not less than 800 grains per slide were made for the purpose of frequency estimations.

### Mineral Constitution of Sands

*Sample No. 1.*—It is mostly an ilmenite-garnet sand. The individual minerals are not well sorted and most of the heavy minerals are angular to subangular in shape. The heavy minerals are constituted by: Ilmenite (46·24%); Garnet (13·58%); Zircon (20·03%); Monazite (5·16%); Pyroxene (7·43%); Kyanite (1·29%); Tourmaline (1·86%) and Rutile (1%).

*Sample No. 2.*—It is essentially an ilmenite-zircon-garnet sand and the minerals are constituted both by sorted and unsorted ones. In this many ilmenite grains are subrounded. The minerals constituting the suite are: Ilmenite (85·52%); Zircon (5·72%); Garnet (3·49%); Monazite (0·71%); Pyroxene (0·66%); Kyanite (0·84%); Rutile (0·71%) and Amphibole (0·42%).

*Samples No. 3 and 4.*—They are essentially ilmenite-zircon sands. Garnets become very scanty, while the zircons become abundant, and monazite becomes conspicuous. The peculiarity of these samples is, that they are fairly well sorted, though many of the zircons maintain their well defined crystal outlines. The heavy minerals comprising the samples are: Ilmenite (76·49%); Zircon (14·76%); Monazite (7·1%); Pyroxene (1·41%); Amphibole (0·84%); Rutile (0·80%); Kyanite (0·35%) and Brookite (0·38%).

*Samples No. 5 and 6.*—These samples are essentially ilmenite-monazite sands, though zircon is found in appreciable quantities. The remarkable feature noticed in these samples is the typical egg-shape of monazite and zircons exhibiting well-defined zoning. The sorting is medium, as compared to the previous samples. The heavy minerals composing the above samples are: Ilmenite (73·87%); Monazite (14·49%); Zircon (12·30%); Rutile (0·96%); Staurolite (0·11%) and Garnet (0·91%).

The heavy minerals that constitute the assemblage of the sands of Cape Comorin, in the order of abundance are: ilmenite, zircon, monazite, garnet, rutile, kyanite, pyroxene, amphibole, tourmaline, zoisite, epidote, andalusite, sillimanite and brookite, of which the first four form the bulk and the rest are accessory in character.

The variation of the heavy minerals in the samples 1 to 6 is represented in Range Table I, after B.O.C. geologist's method.[3] Samples 1 to 3 are distinguished by a more heterogeneous assemblage of minerals (like kyanite, pyroxene, amphibole, andalusite, zircon, monazite and garnet); while samples 4, 5 and 6 are essentially zircon-monazite sands with total impoverishment or sporadic occurrence of other minerals (like pyroxene, kyanite, amphibole and garnet). Besides samples 1 to 3 are characterised by rounded zircons, which dwindle in samples 4, 5 and 6. On the other hand zircon shows a remarkable tendency towards zoning. From the study of the Range Table, it may be seen that samples 1, 2 are mostly garnet-ilmenite sands; while samples 2, 3 and 4 are essentially garnet poor zircon sands and samples 5 and 6 are principally monazite-zircon sands.

The nature and constitution of the heavy mineral assemblage of the sands indicate to metamorphic and acid intermediate plutonic rocks as the probable source rocks for the sediments constituting the sands.

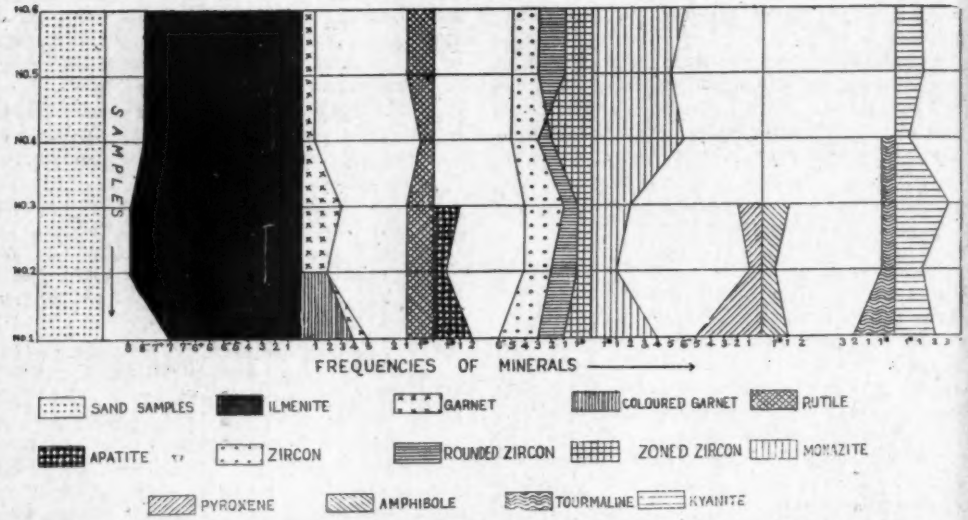
### Shape and Size Study

Size determinations of the heavy mineral constituents were made with the help of Micrometer ocular.[4] The relative lengths and breadths of the various minerals were determined.

The size and shape study indicates, that the minerals are mostly angular to sub-angular, thereby indicating to inferior sorting. But, as we come to samples 5 and 6, we notice that monazite, ilmenite and zircon show a tendency to become subrounded. This feature also lends support to the conclusion arrived at above, namely, that the material has been derived from more than one source.

Further, it has received some material, which has been transported over long distance, as

RANGE TABLE I




evidenced by egg-shaped monazite, subrounded ilmenite and zircon; and some material from a source which is nearer, as evidenced by the idiomorphic outlines of zircon, zoned variety of zircon and platy form of kyanite. The latter minerals cited above vary from angular to sub-angular in shape, thereby pointing to very little evidence of transport.

The regular gradation and transition noticed in the concentration of heavy minerals from samples 1 to 6 (namely, garnet, ilmenite, zircon and monazite in the order of increasing specific gravity), point to residual gravity concentration of minerals in the sands, in the seaward direction.

The authors thank Dr. P. R. J. Naidu, for his general interest and going through the manuscript.

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University of Saugor, S. C. Jacob.
*April* 11, 1961.

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## ORIGIN OF VEMPALLE SHALES AND LIMESTONES IN CUDDAPAH BASIN BASED ON TRACE ELEMENT STUDY

Trace element study of clays in shales and limestones is of recent origin.[1-3] In the present investigation a semi-quantitative study of the elements present has been made in the sediments of the Vempalle stage of the Cuddapah System with the objective of delineating their mode of origin. The stratigraphic succession of the Lower Cuddapahs in the area is as follows:

| | |
|---|---|
| Cheyyeru series | Tadpatri shales |
| | Pulivendla quartzites |
| Papaghni series | Vempalle shales and limestones |
| | Gulcheru quartzites |
| Archæans | Gneisses and granites |

The Vempalle stage can be roughly divided into two divisions, the lower one predominantly shale and the upper one predominantly limestone.

Five samples of shales and five of limestones were collected in the field roughly along the strike (W.N.W.-E.S.E.) of the formation within a distance of 25 miles between Velidendla and Vempalle in the Cuddapah district. The samples were washed, dried, and were treated with enough amounts of 2N HCl to remove the carbonates. After repeated washing with distilled water the samples in suspension were passed through a sieve (less than 66 microns) and were later dispersed with $NH_4OH$ (to give pH 10) and then centrifuged to obtain the clay

fractions (less than 2 microns).[2] The samples were dried in sample tubes. These were arced using a Hilger Large Quartz Littrow Spectrograph.

A perusal of the spectrum of each sample showed that the proportion of each individual element differs slightly from one sample to another. The spectra reveal the characteristic lines of the most abundant elements like Mg, Ca, Fe, Al and Si. The next prominent group of elements identified roughly in the order of abundance are Ti and V followed by Sr, Cr, Co and Cu. Na, K, Mn, Ga, Sc, Sn and Pb are also present. From the intensity and frequency of the spectral lines of nine of the trace elements common to the shales and limestones, it is found that V, Cr, Cu, Sc, Sn and Ga tend to be comparatively more abundant in the shales and Sr, Co and Pb more abundant in the limestone samples. Similar observations of relative abundance have been made by authors elsewhere.[4]

The ionic potential of an element largely determines its place of deposition during formation of sedimentary rocks. Figure 1 shows the fields of soluble cations, hydrolysates and soluble complex anions.[5] On this is circumscribed a field which includes the elements found in the samples. It is significant that this field does not include any element in the field of soluble complex anions. An examination of the geochemistry of the elements B, C, N, P and S shows that these are very insignificant in inorganically formed calcareous sediments and are prominent in sediments of organic origin.[6]

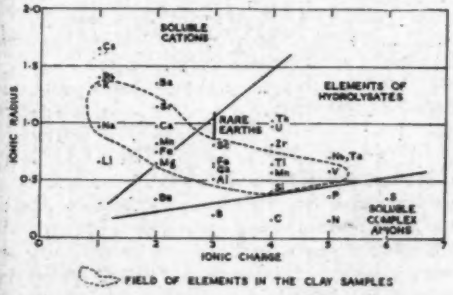


FIG. 1. Geochemical separation of some important elements on the basis of their ionic potential. (After Mason, 1958, p. 157.)

There is further evidence to show that the shales and limestones have been formed in quiet waters in a large basin essentially by chemical processes. The delicate lamination in the siltstones and shales as found in the hillocks near Virannagattupalle (Lat. 15° 20' 5"; Long. 78° 29' 15") and at the road cutting 1½ miles northeast of Kottalu (Lat. 15° 20' 30": Long. 78° 14') are indicative of quiet water deposition.[7] Limestone forms either by physico-chemical changes or by vital processes of organisms. No mega or micro-fossils have been found in the limestones in this area under study, but pisolites and oolites are present. The general consensus of opinion regarding these is that they are of chemical origin.[8]

That there was an uplift of the rocks of the Papaghni series prior to the deposition of the Pulivendlas can be deduced from the fact that the Pulivendla quartzites at their base consist of conglomerates which contain a good proportion of chert pebbles derived from the Vempalle limestones. This uplift considerably shallowed up the basin. It was in these shallow waters that the blue-green algæ, which built up stromatolites,[9] would have thrived. These stromatolites are seen in a few places in the uppermost horizon of the Vempalle limestone. The types found here occur in the intertidal environment,[10] namely in the shallow water horizon.

Hence it can be concluded that the shales and limestones of the Vempalle stage are essentially precipitates of chemical origin, the basin being shallowed towards the end of the Papaghni epoch forming favourable sites for the formation of stromatolites.

My grateful thanks are due to Prof. C. Mahadevan for his guidance and interest in this study.

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## USE OF CHILLED WATER IN PRAWN PROCESSING WORK

A COMPARATIVE study of the effect of using chilled water and tap-water during the various stages of processing of prawn has been made. Five pound blocks of backwater and sea prawns in the headless and peeled and deveined forms were frozen using chilled water below 6° C. and tap-water at or below 25° C. at all the stages of preparation of the products. These were separately sampled at different stages, *viz.*, before washing, after washing, after packing in trays and after freezing for total bacterial plate counts. The washing time usually varied between 5 and 10 minutes, the interval between washing and packing being 30 minutes and that between packing and freezing about one hour during which the trays were kept in a chill storage. For comparison the total bacterial plate counts of frozen products prepared from the same batch using the two types of water are presented in the histogram (Fig. 1).

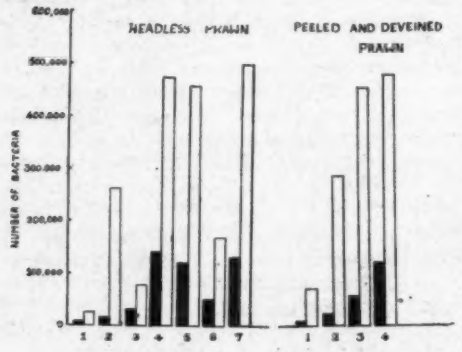


FIG. 1. Histogram showing the difference in the total bacterial plate count of the same samples of headless, and peeled and deveined prawn treated with tap-water and ice-cold water.

It has been noted that there is a uniform reduction in the bacterial counts of the material as a result of washing irrespective of the type of water used. However, samples washed in tap-water show considerable increase in the bacterial counts during the interval between washing and packing, whereas the changes in bacterial counts over the same period in samples treated with chilled water are not significant. There is also wide disparity between the bacterial counts of the two sets of samples washed and glazed with chilled water and tap-water respectively, after freezing (*vide* histogram). It can, therefore, be concluded that the use of chilled water during different stages of processing of prawns helps in keeping down the bacterial load in the final frozen product. It has also been demonstrated to the trade that adoption of this improved processing technique presents no practical difficulties under commercial freezing conditions.

Central Fisheries Technological Research Station, Ernakulam-1, *June* 6, 1961.

V. K. PILLAI.
A. LEKSHMY.

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## THE ARCHEGONIAL COMPLEMENT OF *BOTRYCHIUM LANUGINOSUM* WALL. EX HOOK. *ET* GREV.*

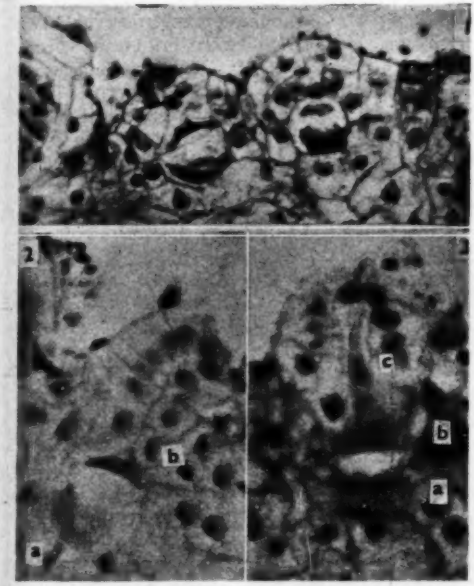
THERE appears to be some difficulty in demonstrating the presence of the ventral canal cell in the archegonial complement of Ophioglossaceæ. This is specially so in the case of *Botrychium*, as can be seen from the views expressed by the previous workers on that genus. The ventral canal cell is ascribed to be ephemeral, very inconspicuous and impossible to detect and hence its very formation itself is doubted.

Jeffrey (1898) figures a very evident ventral canal cell whose nucleus is much smaller than that of the egg or the neck canal cell. He says further, that one rarely finds this canal cell intact, as it quickly disintegrates and in preserved material, at any rate, is represented by an indistinct mass thrust against the wide base of the cervical canal. Bruchmann (1906) was unable to find a ventral canal cell in *B. lunaria* nor did he apparently see the division of the nucleus of the neck canal cell. Campbell (1911) found the ventral canal cell of *B. virginianum* as that of *Ophioglossum* very inconspicuous and often impossible to detect. He could not demonstrate satisfactorily the presence of ventral canal cell in *B. obliquum* although several preparations were secured which indicated that ventral canal cell—at least a nucleus representing this—was present. There was, however, one case where, in close contact with the nucleus of the central cell, a second smaller nucleus was visible and a zone of somewhat denser cytoplasm but no evident cell-wall. A similar difficulty has been experienced in his investigations of other Ophioglossaceæ (Campbell, 1921). It seems probable that in these cases, the ventral canal cell is cut off very soon before the opening of the archegonium and almost immediately ejected. It is not unlikely that there may be no division wall formed and that the ventral canal cell is represented by a nucleus.

Nozu (1954) mentioned a ventral canal cell in *B. japonicum* but gave no illustration to support this statement.

Nishida (1954) was able to see only in one case of *B. japonicum* a nucleus which looked like a ventral nucleus.

According to Eames (1936) the ventral canal cell is inconspicuous and apparently disintegrates early.




FIGS. 1–3. Fig. 1. Section of the gametophyte of *Botrychium lanuginosum* showing the longitudinal sections of two archegonia. The partition wall between the egg cell and the ventral canal cell is seen, × 210. Fig 2. Longitudinal section of an archigonium showing the egg cell and the ventral canal cell, × 350. Fig. 3. Median longitudinal section of an archegonium showing the full complement—an egg cell, a ventral canal cell and two neck canal nuclei, × 350.

In *Botrychium lanuginosum*, however, the author was able to demonstrate clearly the presence of the ventral canal nucleus, the partition wall separating the egg cell from the ventral canal cell as well as the divided neck canal nuclei. Figure 1 shows the venter portion of two adjacent archegonia of which, we can see in the left side one the partition wall between the egg cell and the ventral canal cell. The partition wall appears to be somewhat curved or depressed. The cytoplasm of the ventral canal cell with its nucleus is seen above the partition wall, slightly projecting into the canal region. Below the partition wall, the egg cytoplasm with its nucleus is seen, the nucleus being almost at the bottom. The archegonium on the right side shows the egg cytoplasm with its nucleus and the cytoplasm of the ventral canal cell but the partition wall is not clearly visible. In Fig. 2, the egg nucleus in the middle of the cytoplasm is seen at *a*, while the ventral canal nucleus surrounded by the cytoplasm is seen at *b* above the partition wall almost continuous with it and projecting into the neck canal. In Fig. 3 an enlarged view of an archegonium in median longitudinal section is presented with its full complement. Lower down in the venter at *a* the big egg cell is situated with its nucleus. The clear space just below the partition wall shows that the egg cytoplasm has receded from the partition wall. At *b* above the partition wall is the ventral canal cell with its nucleus as big as that of the egg or slightly smaller. The neck canal is seen very clearly extending almost to the tip of the archegonial neck. Just above the ventral canal cell at *c* we can see two nuclei lying one above the other and touching each other. These are the two neck canal nuclei. There is no sign of a partition wall between them. So the archegonial complement of *Botrychium lanuginosum* consists of an egg cell, a ventral canal cell and two neck canal nuclei, forming the axial row.

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* What was formerly described as *Botrychium virginianum* var. *lanuginosum* S. W (Rao, L.N., 1939) has now been difinitely fixed as *Botrychium lanuginosum* Wall. Ex Hook. *et* Grev.

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## A MICROBIAL DISEASE OF *OPHIUSA CORONATA* FABR. (NOCTUIDAE: LEPIDOPTERA)

*Ophiusa coronata* Fabr. is a pest of the ornamental creeper, *Quiscalis indica*. In certain years severe defoliation of plants occurs as a result of attack by this pest. During July 1960, the appearance of a microbial disease was responsible for almost complete eradication of *Ophiusa* caterpillars at the Indian Agricultural Research Institute farm. When the epizootic had passed it was a common sight to see large number of dead caterpillars fixed to the leaves of the creeper. Most of the diseased caterpillars were in the late larval instars.

The infected caterpillars cease to feed and one of the symptoms of the disease was a slight discolouration of the abdominal segments, which is normally of a dark green colour. The discolouration spreads all over, and after death it changes into a jet dark hue. In the advanced stage the body becomes flaccid and a dark brownish fluid oozes out of its mouth. The cuticle of the abdominal segments soon becomes glossy, moist and more or less transparent, showing the yellowish green inclusion bodies in the diseased cells. There is a general paralysis of the body of the caterpillar except for intermittent tremors of thoracic legs and mouth parts. Upon death which apparently takes place in about 2-3 days after the visible signs of disease appear, the cuticle except in the thoracic and head regions becomes brittle so that the least stress pulls it apart, allowing the fluid containing the inclusion bodies to flow out. Soon after the caterpillar dies, the cadaver breaks down into a decaying mass and the leaf surface gets covered with the exuded material from the caterpillar. Transmission of the virus from the diseased to a healthy caterpillar apparently occurs by way of contaminated food. Further work is in progress.

Thanks are due to Dr. B. P. Pal, Director, and Dr. E. S. Narayanan, Head of the Entomology Division, for their interest in this study.

Division of Entomology, T. V. Venkatraman.
Indian Agri. Res. Inst.,
New Delhi-12, *May* 5, 1961.

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## SOME APHIDS NEW TO INDIA, WITH DESCRIPTION OF A NEW SUBSPECIES

Surveys conducted by the author have resulted in the collection of some interesting species of Aphididæ from West Bengal hitherto unknown from India. Sixteen such species and their host plants are briefly reported here and a new subspecies is described.

*Aphis ruborum* (Börner)[1] : Ex. *Rubus lineatus*. The dorsal hairs are longer than in the European form but further confirmatory observations are necessary. *Acyrthosiphon malvæ* (Mosley)[2] : Ex. *Calceolaria sp. Acyrthosiphon citricola* (v.d.G.)[3] : Ex. *Citrus reticulata, Litsæa polyantha* and *Photinia integrifolia. Schoutedenia lutea* (v.d.G.)[4] : Ex. *Bœhmeria polystachya. Glyphinaphis bambusæ* (v.d.G.)[5] : Ex. *Bambusa* sp. *Ceratoglyphina bambusæ* (v.d.G.)[6] : Ex. *Bambusa sp.* The Indian material differs from the species described from Java by the possession of longer hairs on the frontal horns. It is, however, retained in the same species for the present. *Melanaphis bambusæ* (Fullaway)[7] : Ex. *Bambusa* sp. *Myzocallis kahawaluokalani* (Kirk.)[8] : Ex. *Lagerstrœmia* sp. and *Lawsonia alba. Prociphilus* sp. : Ex. *Tsuga brunoniana. Smynthorodes betæ* Westw.[9] : Ex. Roots of Compositæ. *Nippolachnus piri* Mats.[10] : Ex. *Pyrus communis. Eutrichosiphum vandergooti* Ray Chaudhuri[11] : Ex. *Quercus serrata. Paratrichosiphum tattakanum* (Takah.)[12] : Ex. *Quercus* sp. *Formosaphis micheliæ* (Takah.)[13] : Ex. *Magnolia campbellii* and *M. stellata. Capitophorus formosartemisiæ* (Takah.)[14] : Ex. *Artemisia dentata*. The Indian specimens appear to have considerably longer siphunculi than those described by Takahashi but it seems desirable to retain the Indian form in the main species until Formosan material is available for comparison. *Capitophorus hippophæs* Koch, subsp. *Javanicus* H.R.L.[15] : Ex. *Polygonum* sp., *Cervaphis rappardi* H.R.L., subsp. *indica* nov. subsp. *Apterous viviparous* female.

Morphological characters : Differs from *Cervaphis rappardi* H.R.L.[16] *sensu stricto* as follows : Live colour light-green. Body longer measuring about 1·47–1·69 mm. Marginal branched processi on 5th abdominal tergite always less than half of the maximum width of body; frontal processi including the apical hair always shorter than half the length of antennæ. Siphunculi appreciably shorter than the antennæ, not uniformly pale but distinctly dark near the apices. Other characters as in the main species.

Colonies of this aphid were found to infest the tender shoots and leaves of *Cajanus indicus*, without any marked injury to the host. Uptill now the new subspecies is known only from Matelli, in the district of Jalpaiguri, West Bengal.

The author is grateful to Dr. D. Hille Ris Lambers of Bennekom, Netherlands, for his valuable suggestions and to Dr. S. N. Banerjee,

TABLE I
Measurement in mm.

| No. | Length body | Ant. | Siph. | III | IV | Processi on | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Front | 5th abd. terg. | 7th abd. terg. |
| 1 | 1·55 | 0·43 | 0·35 | 0·208 | (0·056+0·088) | 0·19 | 0·35 | 0·49 |
| 2 | 1·61 | 0·45 | 0·38 | 0·208 | (0·064+0·100) | 0·19 | 0·41 | 0·54 |
| 3 | 1·58 | 0·47 | 0·40 | 0·216 | (0·064+0·112) | 0·19 | 0·35 | 0·54 |
| 4 | 1·58 | 0·45 | 0·33 | 0·192 | (0·072+0·104) | 0·17 | 0·33 | 0·45 |
| 5 | 1·62 | 0·47 | 0·37 | 0·224 | (0·064+0·096) | 0·19 | 0·40 | 0·49 |
| 6 | 1·47 | 0·40 | 0·33 | 0·176 | (0·064+0·080) | 0·17 | 0·37 | 0·48 |
| 7 | 1·69 | 0·48 | 0·40 | 0·216 | (0·072+0·100) | 0·21 | 0·46 | 0·57 |
| 8 | 1·60 | 0·46 | 0·37 | 0·208 | (0·064+0·104) | 0·17 | 0·38 | 0·49 |

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Entomologist, Government of West Bengal, for the facilities provided for the study.

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State Agricultural Res. Inst.,
Calcutta-40, *May* 22, 1961.

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## EFFECT OF BETA RADIATIONS FROM $P^{32}$ ON *BRACON GELECHIAE* ASHMEAD

STUDIES on the effects of beta radiations on insects have received little attention so far. Martin (1948)[1] and Blumel (1950)[2] made some observations on *Habrobracon juglandis* and *Drosophila* sp. respectively. Dent and Amy (1950)[3] also observed some detrimental effects of these radiations on *H. juglandis*. However, Narayanan *et al.* (1959)[4] observed a stimulating effect on the eggs and first instar larvæ of *Corcyra cephalonica* Stainton when irradiated for 24 hours at a dose rate of 1·1 rep./hr. (beta radiations from $P^{32}$). Similar studies were made on the effects of beta radiations on the eggs of *Bracon gelechiæ* Ashmead, a parasite on the potato tuber moth, *Gnorimoschema operculella* Zeller. The results observed are summarised below:

In the present investigation, full-grown caterpillars of *Corcyra cephalonica* previously starved for 24 hours were allowed to feed on the crushed 'Jowar' which was thoroughly mixed with 750 microcuries of $P^{32}$ (30 caterpillars per 30 grams of 'Jowar'). After 24 hours of feeding the caterpillars were removed from the feed, washed with water several times to remove surface contamination and assayed for radioactivity. Caterpillars with radioactivity ranging from 251 c.p.m. to 500 c.p.m. were selected and exposed to the females of *B. gelechiæ* for parasitisation. In the first and second generations, however, normal caterpillars were given for parasitisation. Each treatment was replicated six times and a separate control was also maintained. The experiment was conducted at an average temperature of 82° ± 10° F. and 80% R.H.

TABLE I
*Effect of beta radiations of* 251-500 c.p.m. *intensity on* B. gelechiæ

| | | Parent generation | | First generation | | Second generation | |
|---|---|---|---|---|---|---|---|
| | | Treatment | Control | Treatment | Control | Treatment | Control |
| 1 | Fecundity per female | 16 | 14 | 9 | 6 | 62 | 18 |
| 2 | % viability | 62·4 | 70·6 | 48·6 | 70·5 | 62·6 | 52·3 |
| 3 | % successful completion of development | 50·5 | 56·47 | 33·7 | 50·0 | 46·5 | 32·4 |

These studies on the life-history of *B. gelechiæ* indicate that the fecundity, percentage viability and percentage successful completion of development were adversely affected in the parent

generation and more or less the same trend was maintained in the first generation (Table I). However, in the second generation, the fecundity, percentage viability and percentage successful completion of development were more than that in the control.

It was observed that the fecundity of *B. gelechiæ* in the control was much less than that reported by earlier workers. This fact can be attributed to the ecological conditions under which the present studies were conducted. However, on the whole, the beneficial effects of beta radiations on this insect are evident from the data and it may be said that these radiations have a stimulating effect on the life-processes of *B. gelechiæ*.

The authors are thankful to Dr. E. S. Narayanan for his keen interest in this work.

Division of Entomology, Indian Agric. Res. Inst., New Delhi-12,
*May* 24, 1961.

Snehamoy Chatterji.
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P. N. Saxena.
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## ESTIMATION OF CELLULASE IN THE VENTRAL CAECA OF *ORCHESTIA GAMMARELLA* PALLAS

The capability of digesting cellulose is a rare phenomenon among crustaceans. Nicholls (1931)[1] tried to investigate the presence of cellulase in *Ligia* but did not succeed.

As *Orchestia* feeds happily on paper and cloth, it was considered desirable to find out if cellulase is present in any part of the gut or accessory glands of the animal. It was detected that, although cellulase is not present in any part of the alimentary canal proper, it is present in the secretory cells of the ventral hepato-pancreatic cæca. The two pairs of very long cæca arise as ventral outgrowths of the gut at the junction of the foregut and midgut. The following experiments were performed with respect to the cæcal extract of *Orchestia*.

A few drops of concentrated (10%) extract of cæca were placed on a piece of ulva frond; this was examined under microscope after a few weeks. It was found that the cell-walls of the frond were all intact.

A 1% Fucoid solution was then incubated with the cæcal extract prepared in distilled water. The mixture was tested after 72 hours for the presence of reducing sugars by the Benedict's solution which gave positive results. A 1% soluble Laminarin solution was similarly incubated with the extract which also gave positive results for the presence of reducing sugars, when tested after 72 hours. Finally, a 1% solution of sodium carboxy methyl cellulose when incubated with the caecal extract also indicated the presence of cellulase in the cæca. The quantity used in each incubation included 1 ml. of extract and 1 ml. of the substrate. The control experiments were also set up in all these cases, which gave negative results.

The above experiments reveal that a weak cellulase is present in the cæcal cells of *Orchestia*.

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*June* 16, 1961.

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## GROWTH REGULATORS AND ROOTING OF CUTTINGS IN *ANTIRRHINUM MAJUS* BENTH AND HOOK. (SNAPDRAGON)

*Antirrhinum majus*, a perennial propagated by seeds, belongs to the family scrophulariaceæ, and is known for its flowers of remarkable shades of colour.[1] Since seed propagation gives rise to variations in flower colour, attempts were made to propagate the plants by stem cuttings with the help of growth regulators. Observation on the effect of growth regulators on rooting of cuttings is reported in this note.

Matured shoots of uniform length of about 6" were selected from 3½–4 months old plants to prepare cuttings. Indole acetic acid, indole butyric acid and naphthalene acetic acid were used individually in concentrations of 4,000 p.p.m., 3,000 p.p.m., and 2,000 p.p.m. and in combinations of IAA *plus* IBA; IAA *plus* NA A and IBA *plus* NAA, in concentrations of 2,000 p.p.m. and 1,000 p.p.m. The hormone powder was dissolved in alcohol and the solution was mixed with active carbon. The mixtures were dried and powdered well. The cuttings, with leaves on, were moistened in water and dipped in hormone powder and then planted in seed pans containing sand and red earth in equal proportions. There were twenty-five cuttings in each treatment. Cuttings were examined for rooting at weekly intervals and

forty days after the treatment they were lifted up for final observations. Results are summarised in Table I.

TABLE I

*The effect of IBA, NAA and IAA and combinations of the three on rooting percentage, nature of rooting and average length of longest root in the cuttings of* Antirrhinum majus

| Sl. No. | Hormones in p.p.m. | Percentage of rooting | Nature of rooting | Average length of longest root in cm. |
|---|---|---|---|---|
| 1 | IAA | | | |
| | (*a*) 4000 | 12 | Sparse | 9·0 |
| | (*b*) 3000 | 64 | Profuse | 8·2 |
| | (*c*) 2000 | 12 | Sparse | 5·0 |
| 2 | IBA | | | |
| | (*a*) 4000 | 32 | Profuse | 7·0 |
| | (*b*) 3000 | 52 | Profuse | 10·5 |
| | (*c*) 2000 | 48 | Sparse | 9·5 |
| 3 | NAA | | | |
| | (*a*) 4000 | 40 | Sparse | 6·5 |
| | (*b*) 3000 | 4 | Negligible | .. |
| | (*c*) 2000 | 24 | Sparse | 4·5 |
| 4 | IAA *plus* IBA | | | |
| | (*a*) 2000 | 46 | Sparse | 3·6 |
| | (*b*) 1000 | 60 | Profuse | 5·5 |
| 5 | IAA *plus* NAA | | | |
| | (*a*) 2000 | 66 | Profuse | 7·9 |
| | (*b*) 1000 | 26 | Sparse | 4·8 |
| 6 | IBA *plus* NAA | | | |
| | (*a*) 2000 | 53 | Profuse | 4·3 |
| | (*b*) 1000 | 20 | Negligible | .. |
| 7 | IAA *plus* IBA *plus* NAA | | | |
| | (*a*) 2000 | 66 | Profuse | 4·0 |
| | (*b*) 1000 | .. | .. | .. |
| 8 | Control | 26 | .. | 3·0 |

Combinations of hormones induce better rooting than individual hormones (Fig. 1). Of the three hormones IBA ranks first in inducing roots. Lower concentrations proved to be generally unfavourable except in combination of IAA *plus* IBA. Rooting in cuttings was found to commence from second week after the treatment. Rooting response seems to be intimately connected with the penetration of hormones through epidermis and cortex up to the pericycle region requiring high concentration as in other woody sps.[2]

We are grateful to Sri. B. Venkoba Rao, Principal, for providing facilities and to Dr. H. C. Govindu, Plant Pathologist (Research and Education), for helpful suggestions. Our thanks are due to Sri. K. Shankar, Lecturer in Chemistry, for help in preparation of hormone powders.

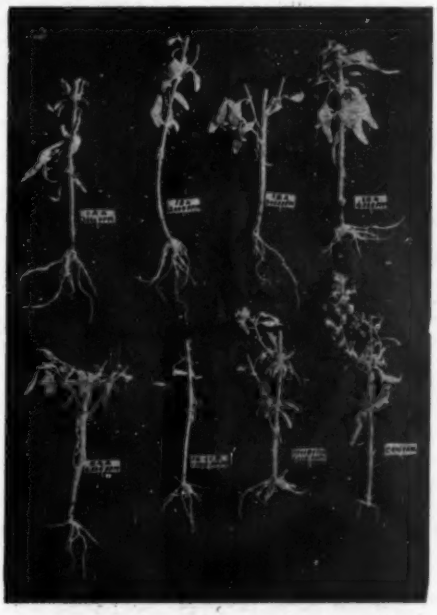

FIG. 1. Rooted cuttings (after 40 days).

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## CHROMOSOME NUMBERS IN SOME FORAGE GRASSES

THIS note seeks to record chromosome numbers as determined on some of the species of forage grasses under study in this Division. These counts constitute new or first records, in the sense that the number have either not been reported before or have been reported differently.

The material was grown under uniform nursery conditions as suggested by Patil (1955). The flower-buds were fixed in acetic alcohol saturated with ferric acetate and stained in propiono-carmine according to the schedule

TABLE I

| S. No. | Species | Source | I.A.R.I. Acc. No. | Chromosome numbers: Present material 2n | Present material n | Present material: Configurations at Metaphase I and some other features | Previous reports 2n | Previous reports n | Previous reports: Authors |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | *Cenchrus glaucous* MCR and S DD | Coimbatore | .. | .. | 18 | 0-5, 0-1, 9-18, 0-4 IV III II I | .. | .. | .. |
| 2 | *Cenchrus glaucous* MCR and S DD | do. | .. | .. | 19 | 0-6, 0-2, 8-16, 0-4 IV III II I | .. | .. | .. |
| 3 | *Cenchrus pennisetiformis* Rochst. | Rajasthan | I.W. 1537 | 35 | .. | 0-6, 0-3, 3-17, 0-4 IV III II I (1-3 Univalents dividing at anaphase I) | .. | .. | .. |
| 4 | *Cenchrus pennisetiformis* Hochst. | do. | I.W. 1537 | 54 | .. | 0-1, 0-1, 0-3, 0-2 VI V IV III 20-27, 0-6 II I (1-5 Univalents dividing at anaphase I) | .. | .. | .. |
| 5 | *Cenchrus setigerus* Vahl. | do. | I.W. 1543 | 37 | .. | 0-5, 0-1, 8-18, 0-3 IV III II I (1-2 Univalents dividing) | 34 36 | .. | From Darlington and Wylie, 1955 |
| 6 | *Iseilema fragile* Blacke | Australia | E.C. 14337 | .. | 9 | All bivalents; one pair conspicuously bigger sized | .. | .. | .. |
| 7 | *Panicum coloratum* L. | do. | E.C. 14124 | .. | 27 | All bivalents | .. | 9 18 16 | Joshi *et al.*, 1959 |
| | | | | | | | | and 18 +1 to 3 B-Chromosome | Swaminathan and Nath, 1956 |
| 8 | *Panicum turgidum* Cheval. | Rajasthan | .. | .. | 27 | Mostly bivalents; occasional univalents | .. | .. | .. |
| 9 | *Pennisetum trisetum* Leeke | Kenya | .. | .. | 18 | Mostly bivalents, one pair deeply stained. Laggards bridges, fragments were seen at anaphase I; 1-3 Univalents dividing at anaphase I | .. | .. | .. |

described by Swaminathan *et al.* (1954) for pollen mother cells. Chromosome counts were made at diakinesis and Metaphase I.

As would be seen from Table I, the species listed 1 to 5 are polyploids in nature while Nos. 7, 8 and 9 appear to be functional diploids. *Iseilema fragile* seems to be a true diploid. It may also be noted that in the case of a single culture of *Cenchrus pennisetiformis* different chromosome numbers were discovered, indicating the existence of intraspecific chromosome races.

Division of Botany, Indian Agric. Res. Inst., New Delhi-12, *May* 11, 1961.

B. D. PATIL.
MISS. S. K. VOHRA.
A. B. JOSHI.

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## A STUDY ON THE EFFECT OF IAA AND TIBA ON VERNALISED PADDY

To study the interaction of growth regulating hormones with vernalization an investigation was undertaken with a summer variety of rice from Bengal (Charnock) using an auxin (IAA) and an anti-auxin (TIBA) in three different concentrations, 10·0 p.p.m., 0·10 p.p.m. and 0·001 p.p.m. respectively.

The seeds were first soaked in distilled water at room temperature for 10 hours and then put in the three different concentrations, kept in separate petri dishes. A control in distilled water was also maintained. For the purpose of vernalization, the dishes were kept inside a refrigerator for 4 weeks and the temperature was maintained at 12° ± 1° C. Every alternate day the old solution was removed and fresh solution added. The seeds were subsequently germinated at room temperature for 24 hours and the sprouted seeds were sown in pots. A batch of untreated seeds soaked overnight in distilled water was also sown and this acted as general control. There were thus 8 treatments in all.

The flowering behaviour has shown almost the same tendency in both years (Table I). In comparison with untreated, unvernalized plants, the vernalized plants showed no significant difference in flowering. Whereas plants where both the vernalization and auxin or anti-auxin treatments were given behaved differently ; when treated with 10·0 p.p.m. of IAA, the flowering was significantly delayed but under lower concentrations as 0·001 p.p.m., a slight accelerating effect was recorded. In case of TIBA, on the other hand, under all the concentrations a delay in flowering was recorded and this was significant under concentrations of 10·0 p.p.m. and 0·1 p.p.m.

The difference in flowering time between the two years is perhaps due to seasonal effect consequent on different time of sowing in the two years. From previous experience vernalization brings on earliness of flowering in rice only by a few days and in the present experiment this result is not apparent and with the hormone treatment there is either no change in the flowering time or it is delayed by a few days. However, these results are closely in corroboration with the work of Kojima *et al.* (1957) on Japanese radish where they found that the application of NAA, KIA or TIBA to seedlings at their very early stages neither had the effect to induce flower initiation of plants which were not subjected to low temperature, nor to promote the bolting of plants already vernalized.

The interaction between vernalization and growth regulating substances is not well understood. Further investigation in this connection seems necessary.

TABLE I

*Flowering time in days under different treatments*

| | Treatments | Date of sowing 1-6-1957 No. of days taken for flowering | Date of sowing 22-4-1958 No. of days taken for flowering |
|---|---|---|---|
| 1 | Control (only overnight soaking in distilled water) | 96·3±0·9 | 108·3±0·8 |
| 2 | Vernalized at 12° ±1° C. for 4 weeks in distilled water | 99·9±1·5 | 109·0±1·5 |
| 3 | do. in 10·0 p.p.m. IAA soln. | 109·6±1·2* | 112·3±1·2* |
| 4 | do. in 0·1 p.p.m. IAA soln. | 95·2±0·7 | 107·5±0·7 |
| 5 | do. in 0·001 p p.m. IAA soln. | 91·7±1·5* | 104·7±0·5* |
| 6 | do. in 10·0 p.p.m. TIBA soln. | 102·6±1·2* | 114·0±1·4* |
| 7 | do. in 0·1 p.p.m. TIBA soln. | 101·5±1·1* | 115·3±1·1* |
| 8 | do. in 0·001 p.p.m. TIBA soln | 98·3±1·4 | 109·8±0·8 |

* Significant at 5% level.

I am much indebted to Prof. P. K. Sen for his valuable suggestions and encouragement.

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*March* 14, 1961.

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# REVIEWS

**Advances in Chemical Physics, Vol. III.** Edited by I. Prigogine. (Interscience Publishers, New York-1, N.Y.), 1961. Pp. ix + 372. Price $ 11.50.

We had occasion to mention the general features and the importance of this series when we reviewed the second volume in these pages (*Curr. Sci.*, 1961, 30, 157). The present volume contains the following eight articles: (1) Mechanisms of organic electrode reactions by P. J. Elving and B. Pullman; (2) Non-linear problems in thermodynamics of irreversible processes by Thor A. Bak; (3) Propagation of flames and detonations by J. O. Hirschfelder and C. F. Curtiss; (4) Large tunnelling corrections in chemical reaction rates by H. S. Johnston; (5) Aspects Recents du Diamagnetisme (in French) by A Pacault, J. Hoarau, and A. Marchand; (6) Powder electrodes and their applications by W. Tomassi; (7) Variational principles in thermodynamics and statistical mechanics of irreversible processes by Syu One, and (8) Electron diffraction in gases and molecular structure by O. Bastiansen and P. N. Skancke.

In the article on *Organic electrode reactions* the authors have summarized current approaches to the problem of the elucidation of the mechanism of the half-cell reaction for the electrolysis of an organic compound at an electrode. Another article in this field of study is the one by Tomassi on *Powder electrodes* where this technique is described and data are given on the applications of powder electrode electrolysis in potentiometric investigations of adsorbents, contact substances and dispersed crystal organic substances.

The two articles on thermodynamics of irreversible processes are of a highly mathematical nature and take the interested readers to the latest developments in this field of study.

The article on Diamagnetism, which is in French, gives a comprehensive survey of the subject giving the experimental methods of measuring diamagnetic susceptibility, the theories connected with them, magnetic susceptibilities of metallic crystals, graphite (mono and polycrystalline), etc.

There is a large mass of experimental data available on the behaviour of flames and detonations. However, the mathematical difficulties involved in connecting the chemical kinetics to the fluid flow properties are many. In the article on *Propagation of flames and detonations* the authors restrict themselves to steady state problems in which the flow is not only laminar but also one-dimensional. In this case exact solutions are possible for a unimolecular reaction, and the article explains the mathematical procedure required to treat an arbitrary system of chemical kinetics.

Renewed interest on electron diffraction methods has been stimulated by improved and more accurate experimental equipment which has enabled the method to be applied to solve structural problems of greater complexity. In the last article the authors, taking examples from the work on gases done at the Institute of Theoretical Chemistry, Norway, have explained in a lucid manner the types of problems on molecular structure one can hope to solve by this method such as precision measurements of internuclear distances, valency angles, interplanar angles, vibrational amplitudes etc.

A. S. G.

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**Treatise on Analytical Chemistry.**—*Theory and Practice.* Edited by I. M. Kolthoff and P. J. Elving, Part I, Vol. 2. (The Interscience Encyclopedia, Inc., New York), 1961. Pp. xx + 811–1,308. Price $ 16.00, Subn. $ 14.00.

The progress and development of analytical chemistry during the first half of this century has generally been covered in well-known textbooks and a number of special monographs. However, a tremendous expansion of the subject has taken place during the last one or two decades. Many of the new molecular, atomic, sub-atomic and nuclear properties that have been discovered in recent years have already found analytical application, and the field of instrumentation also has kept pace with this rapid development. The need for a comprehensive treatise on the subject which will serve as an immediate reference book has been felt not only by researchers working in academic institutions but also by analytical chemists attached to industrial laboratories.

The *Treatise on Analytical Chemistry* edited by I. M. Kolthoff and P. J. Elving aims at presenting a "concise, critical, comprehensive, and systematic, but not exhaustive, treatment of all aspects of classical and modern analytical chemistry". The Treatise will be in three

parts : I-Analytical Chemistry and its Methods ; II—Analytical Chemistry of the Elements ; and III—The Analytical Chemistry of Industrial Materials.

The book under review is Vol. 2 of Part I, and contains two sections, namely, Section B, on Application of chemical principles to analytical chemistry (continued from Vol. I), and Section C, on Separation : principles and techniques.

Section B, on Reactive groups as reagents, exhaustively deals with their organic and inorganic applications, Section C, on Separation deals amongst other things with Diffusion methods, Electromigration and electrophoresis, Distillation, and Vacuum methods.

Throughout the treatment the emphasis is on the analytical significance of properties and of their measurement. As a source book of information and as a guide to the efficient use of the more exhaustive treatments on specific topics, this treatise should find a place in all analytical chemistry laboratories.

A. S. G.

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**Synthetic Ion-Exchangers.** (*Recent Developments in Theory and Application.*) By G. H. Osborn. (Chapman and Hall Ltd., London), 1961. Pp. x + 346. Price 50 *sh.*

With the publication of a few monographs on ion-exchangers like Dr. Kitchener's appearing in the Methuen's *Monographs on Chemical Subjects* and the book, *Ion-Exchangers in Organic and Biochemistry* (Editors : Kressman and Colman) the usefulness of this book is considerably affected. Half the book contains a bibliography of papers on ion-exchange resins, classified according to applications. This feature, which is highly commendable, has added both material and scientific weight to the book. Bibliography II, theoretical, is not comprehensive and up-to-date. There are a number of typographical errors.

The text proper contains the following chapters : (*i*) The structure, preparation and general properties of ion-exchange resins ; (*ii*) Performance data on commercially available resins ; (*iii*) Analytical aspects ; (*iv*) Reactions with materials of low solubility ; (*v*) Ion exclusion ; (*vi*) Ion retardation ; (*vii*) Ion-exchange membranes ; (*viii*) Therapeutic applications ; (*ix*) The use of ion-exchange in the control of trade effluent ; (*x*) The economic large-scale production of deionized water ; (*xi*) Resins as catalysts ; (*xii*) Pulsed or jigged-bed technique ; (*xiii*) Newer large-scale processes utilising ion-exchange resins.

The first edition of this book contained only seven chapters. Chapters (*vi*) and (*ix*) to (*xiii*) are the additions made in the edition under review. Much of the topical material, particularly the contents of chapters (*ii*), (*v*), (*vi*) and (*vii*) seem to have been taken from the literature supplied by the manufacturers of ion-exchange resins. As a result the book, although packed with usefulness lacks the embellishment to be found in a British scientific monograph. The book particularly the topics on the use of ion-exchange in the control of trade effluent, the economic large-scale production of deionized water, pulsed or jigged bed technique and the newer large-scale processes utilizing ion-exchange resins should prove useful to chemists and chemical engineers working in some of our university and national laboratories.

The chapter on ion-exchange membranes could have been brought up-to-date by incorporating the theoretical work of Scatchard, Kirkwood and Staverman on Membrane Potentials and the experimental work related thereto.

N. Lakshminarayanaiah.

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**Extractive Metallurgy of Copper, Nickel and Cobalt.** Edited by Paul Queneau. (Interscience Publishers, New York, London). Pp. xv + 647. Price $ 22.50.

This book contains a collection of papers presented at the International Symposium held in New York in February 1960 which was sponsored by the Extractive Metallurgy Division of the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers. The coverage in this Symposium Volume deals with the modern practice in the extractive metallurgy of Copper, Nickel and Cobalt, an understanding of which is of great importance to both the maker and user of these metals.

The papers have been classified in this book in five sections with a separate and excellent annotated bibliography containing some 1,190 references.

The first section under the caption 'General' contains 6 papers and the discussions, thereon ; the subjects dealt with are the advantages of fluid bed roasting, treatment of Nickel-Copper matte, solvent extraction, separation by volatilization and corrosion-resisting materials of construction.

The second section on 'Fuel fired smelting and converting' has 4 papers dealing with the present practice at the Noranda and Gaspo smelters, of Phelps Dodge in Arizona, the Chino Mines

Division of Kennecott Copper Corporation and aspects on the design and operation of Copper converters.

Next follows the section on 'Electric Furnace Smelting' dealing with four papers, on smelting of sulphide ores, production of Ferronickel from low-grade Nickel ores of Oragon, the New Caledonian practice of Ferronickel smelting and on the smelting tests of Nickeliferous serpentine.

'Atmospheric and elevated pressure leaching' forms the caption of the next section which deals with 3 papers, on the present practice of Oxide concentrate leaching and electro winning, on the Chuquicamata leaching practice, and on the Sulphuric acid pressure-leaching of Nickeliferous laterites.

The last section on 'Refining' covers 6 papers dealing with the current operating practice in electrolytic Copper refining, with the role and significance of Dialysis in modern electrolyte purification, the Chuquicamata practice of tank house operation, production of refined Nickel and on the present practice of Cobalt recovery by the electrolytic and pressure hydrometallurgy techniques.

The subject-matter in this book has been well supplemented by some 88 illustrations, 52 graphs, 88 tables, 34 flow sheets and 10 microphotographs.

The Symposium Volume, though it presents the current status of the extractive Metallurgy practice of Copper, Nickel and Cobalt only, throws a challenge to the men of metals on the dynamic and new possibilities, in the fields of Hydro-Metallurgy, Pyrometallurgy and the Vapometallurgy. And this book is a 'must' for not only to the non-ferrous process metallurgist, but also to the serious-minded researcher ever in pursuit of the metals locked up either in the muds of the earth or in the waters of the sea.

A. A. KRISHNAN.

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**The Physical Principles of Astronautics.** By Arthur I. Berman. (John Wiley and Sons Ltd., 440, Park Avenue South, New York-16), 1961. Pp. xv + 350. Price $ 9.25.

Astronautics has become a subject by itself and before long it will find an adequate place in the curricula of Indian Universities. The book *The Physical Principles of Astronautics* will be found to be a suitable introductory text-book on the subject for a one-year course at the undergraduate level. Besides, beginner students of astronomy also will find many fundamental problems dealt with in a lucid manner.

The book is divided into three parts. Part I, of about 70 pages, deals with the elementary principles of Astronomy, especially with reference to the earth and the moon, and the physics of the solar system. In Part II, of about 50 pages, the fundamental concepts of mechanics, such as mass, weight, potential energy and Coriolis force are discussed in an elementary manner. In Part III, on dynamics of space flight, the properties of orbit, orbital perturbations, and propulsion dynamics are described. There is an appendix which gives a glossary of astronautical terms.

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**An Introduction to the Laplace Transformation with Engineering Applications.** By J. C. Jaeger. (Methuen's Monographs, Methuen and Co., Ltd., London), 1961. Pp. viii + 156. Price 10 *sh.* 6 *d.*

Methuen's Monographs on Physical Subjects are well-known and have become indispensable additions to the book-shelves of university students of physical sciences and engineering. The booklet under review is the second edition, the first of which was published in 1949. The less difficult approach to solving transient problems by the Laplace Transformation method rather than by the operational calculus method of Heaviside has become popular with students of engineering and physics. In the present edition the author has added a useful chapter giving a brief sketch of the theory of functions of a complex variable and the way in which it is applied in conjunction with the inversion theorem.

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**Paint Technology Manuals.** Part I. *Non-Convertible Coatings.* (Published on behalf of Oil and Colour Chemists' Association. Chapman and Hall, London), 1961. Pp. 326. Price 30 *sh.*

This book has been brought out as first volume of the series on paint technology manuals by the Oil and Colour Chemists' Association and it is primarily intended to meet the requirements for the examination of the City and Guilds of London Institute. The 11 Chapters of this volume are based on the contributions of experienced technologists from the industry and are devoted to coating materials that do not undergo any chemical change during their application.

A large portion of the book deals with cellulosic lacquers wherein cellulose nitrate predominates. Shellac, which is one of the oldest non-convertible coating materials is only casually mentioned although even today it has an important place in wood-finishing and other similar applications. Discussion on wood finishes includes polyesters, epoxide resins, polyurethanes

and malamine-alkyd formulations for coatings, which strictly speaking do not fall within the scope of the title of this book.

The chemistry of the preparation and general characteristics of cellulose nitrate, cellulose acetate and ethyl cellulose are briefly described in Chapters 1, 7 and 8 respectively. The other ingredients of cellulose nitrate base lacquers, *i.e.*, solvents, plasticisers and pigments are adequately dealt with in Chapters 2, 3 and 4. Various chemical derivatives of rubber that find use in coatings and allied fields are briefly discussed in Chapter 9. Preparation and properties of vinyl resins with particular reference to the choice of solvents for their use as organosols, plastisols and wash primers are covered in a rather lengthy Chapter No. 10. The last Chapter (No. 11) on spirit varnishes is rather sketchy. Practical examples at the end of each chapter should be of help to students.

Authors have attempted to bring out important theoretical and practical aspects of non-convertible coatings so that one has a fairly clear idea of the type and significance of the different materials used in the preparation and application of such formulations. The inclusion of a few illustrations and a bibliography at the end of each chapter for further reading should enhance its value. This book should be useful in the training and education of paint technologists, apprentices and students taking up the City and Guilds examinations. It should be equally helpful as a guide to those engaged in the manufacture and use of lacquers.

S. L. KAPUR.

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**Plant Nematodes, their Bionomics and Control.** By Dr. Jesse R. Christie. (Gainesville, Florida; Agricultural Experiment Stations, University of Florida), 1959. Pp. 256. Price $3.75.

Recently the plant parasitic nematodes have been observed to cause extensive damage to our food crops, orchards and ornamentals. Information on the bionomics and control of these nematodes is widely scattered and publications on the subject are available only in a few libraries. Compiled for easy reference information, this book will be invaluable to research workers on plant nematodes, especially those located at field stations with limited library facilities.

The book is divided into fourteen chapters, the first being a general introduction to plant nematodes. In the second chapter are discussed the principles of namatode control. The remaining chapters deal with one group each of the related nematodes. Each chapter deals with the taxonomy of the group under consideration, its life-history and habits, injury caused to the plants, hosts, distribution of the nema and control. The author has provided five useful tables in the Appendix. The first lists the plant nematodes of some common crops, the second gives the control measures, the third deals with hot water treatments for denematizing planting stock, the fourth contains the common names of plant parasitic nematodes and the fifth gives a list of scientific names of nematodes attacking plants and their synonyms.

Well illustrated and pleasingly written, the book is likely to prove helpful not only to research workers but also to students, teachers, farmers and others interested in growing plants and concerned with the problem of nematode control.

PUSHKARNATH.

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**A Second Course in Statistics.** By Robert Loveday. (Cambridge University Press, Bentley House, 200, Euston Road, London, N.W. 1), 1961. Pp. xi + 155. Price 10 *sh.*

This is an admirable elementary text-book on Statistics suitable for use in the first year of the university course where the principles and applications of statistics are taught. The chapters are in logical sequence leading to a short account of Quality Control followed by a treatment of regression lines by the method of least squares and of correlation coefficients.

The large number of examples in the text and exercises at the end of the book will be particularly useful to students in gaining confidence in their reading.

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**Studies in Indian Medicinal Plants Used in Ayurveda—Cathartics.** By G. S. Pendse and M. A. Iyengar. (The Indian Drugs Research Association, Poona-5), 1961. Pp. iv + 106.

Those interested in Ayurvedic medicines and the plants from which they are prepared will find much useful material in this 100-page publication of the Indian Drugs Research Association, Poona. The controversial question about Ayurvedic drugs is whether such drugs extracted from medicinal plants by chemical methods prove as efficacious as those administered in their natural state. The problem can be solved only if the original Ayurvedic concepts relating to drug-action and drug-composition are fully understood. The study of the medicinal plants also must be oriented in such a way as to obtain maximum information in accord with these concepts. In this context the

authors have brought to bear their wide knowledge and results of their researches into relevant original texts, in the publication of this issue of the I.D.R.A.

The two drugs and the corresponding plants taken up for detailed study in this issue are Danti (*Baliospermum montanum* Muell Arg) and Trivrt (*Operculina turpethum*).

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**C.S.I.R.O. Research Review, 1959-60.** (commonwealth Scientific and Industrial Research Organization, Melbourne, Australlia). Pp. 418.

The record of the activities of the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.) for the year 1959-60 is contained in the two publications, the *C.S.I.R.O. Twelfth Annual Report* and the *C.S.I.R.O. Research Review*. Apart from information of a general administrative nature the *Report* issued earlier contained only the highlights of the research program in popular language to meet the interest of the general public. The purpose of the *Research Review* is to present the scientific details of the research programme which primarily will be of interest to the scientific community. There are about 40 chapters, each chapter being devoted broadly to one Division or Section of C.S.I.R.O.

Agricultural Sciences take priority in this Review, followed by the various sections of Chemistry, Physics, Meteorology and Industrial Research. The Division of Chemical Physics reports studies done during the year in Crystallography, Solid State Physics and Spectroscopy. One of the main responsibilities of the Division of Physics is the maintenance of the International Temperature Scale (I.T.S.). Recent developments relating to the maintenance of the I.T.S. include those in Resistance thermometry, Thermocouple and Optical pyrometry, Temperature scale in the range 0-4° K., and Cryogenics. The other activities of the Division of Physics include Hygrometry, Photometry and Colorometry, and Solar physics.

The *C.S.I.R.O. Research Review* is a publication of current scientific value in various fields and should be in the possession of all organisations of research and scientific administration.

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**Grasses of Burma, Ceylon, India and Pakistan.** (Excluding Bambuseæ). By N. L. Bor. (Pergamon Press, London), 1960. Pp. xviii + 767. Figs. 80. Price £ 8-0-0.

The identification and description of grasses has always posed a difficult problem to botanists, foresters and agriculturists. The account of grasses contained in the Seventh Volume of Hooker's *Flora of British India* was published as early as 1896 and stood in urgent need of revision for a long time. Bor's book published by Pergamon Press fulfils this long-felt need and provides an admirable answer to this colossal task.

The book is divided into two parts—the General and the Systematic.

The general part is rather brief and consists of four chapters. Chapter I gives the morphology of all the parts of the grass plant, vegetative as well as reproductive, with remarks on their significance in grass systematics. These have been illustrated with examples. These notes based as they are on the vast experience of the author and his close familiarity with the taxonomy of this family will be of great value to students of agrostology who must learn to appreciate the relative value of different morphological characters. Chapter 2 deals with the various modes of dispersal of grasses. Chapters 3 and 4 which deal with the economic aspect of the grasses draw the attention of the reader to their multifarious uses, as also to some of their harmful effects. The grasses which are used as cereals, fodder, essential oils, and those which are used in medicine and conservation of soil moisture have been briefly described. Among the harmful relations are mentioned the poisonous grasses, weeds and those which cause mechanical injury to the cattle.

The systematic part forms the bulk of the book. The introductory chapter deals with Taxonomy and Phylogeny, and reviews the development of taxonomy from 1812. The bases of classification during the early period are discussed. Recent trends in taxonomy, based on the study of cytology, leaf anatomy, embryo, root hairs, shot apex, etc., are also briefly dealt with. Bor writes "Until we accumulate a great deal more data the New Systematics poses as many problems as it solves". This view will receive applause from all orthodox taxonomists.

The systematic list of grasses covers about 700 pages. The term 'list' is appropriately used as detailed descriptions of genera and species are not given and only references have been cited for this purpose. This is justified considering the large number of species which had to be packed into a volume of convenient size and nothing better could be expected, yet full descriptions of genera and species will be missed by most people using this book. Due to frequent amputation of small new genera from large old ones the circumscription and satisfactory descriptions of the latter is a difficult task, and

the agrostologist looks to future for a 'Genera Graminearum'.

Carefully tested dichotomous keys are provided for groups, tribes, genera, species and even varieties. The alphabetical arrangement of tribes within groups, genera within tribes and species within genera may be found convenient for reference, but with a good index already appended to the book this arrangement could have been replaced by placing related genera near each other. The treatment of closely similar genera like *Bothriochloa* and *Dichanthium*, *Isielema* and *Themeda* far apart in the book may not be very convenient to users. The object of verbatim repetition of *Erianthus* species under *Saccharum* is not quite clear.

The significant feature of the book is the exhaustive synonymy for all species. Brief notes are given on their general world distribution, distribution in India, and their uses. A few representative collections have also been cited at the end of descriptions. Chromosome numbers wherever known have also been given. The book incorporates practically all the relevant findings on the grasses of this region upto-date. A number of new species, new genera and new names have been incorporated as appendix or addenda even during the course of publication. It has an exhaustive bibliography of about 600 entries which will be of great help to future workers on this difficult group.

The printing, line drawings, and get-up of the book are of high order.

The full value of such an important work can only be revealed by long study and use. No research institution dealing with forestry, agriculture or botany can afford to be without this book which will remain a valuable work of reference for many years to come.

M. B. RAIZADA.

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**Books Received**

*Optical Microscope Technique*. By D. Birchon. (George Newnes Ltd., Tower House, Southampton Street, London, W.C. 2), 1961. Pp. x + 274. Price 60 *sh*.

*Physical Chemistry* (2nd Revised Edition). By E. A. Moelwyn Hughes. (Pergamon Press, 4 and 5 Fitzroy Square, London, W. 1), 1961. Pp. vii + 1,333. Price 84 *sh*.

*Relativistic Electron Theory*. By M. E. Rose, (John Wiley & Sons, N.Y.), 1961. Pp. xii + 302. Price $ 9.50.

*Symposia of the Society for Experimental Biology, No. XV—Mechanisms in Biological Competition*. (Cambridge University Press, London, N.W. 1), 1961. Pp. vi + 365. Price 50 *sh*.

From: Interscience Publishers, 250, Fifth Avenue, New York-1, N.Y.:

*Fatty Acids, their Chemistry, Properties, Production and Uses*. Part 2. Edited by K. S. Markley, 1961. Pp. ix + 715–1,485. Price $ 27.00.

*The Chemistry and Mode of Action of Herbicides*. By A. S. Crafts, 1961. Pp. viii + 269. Price $ 9.00.

*Metallurgical Society Conferences*. (Vol. 9). *Response of Metals to High Velocity Deformation*. Edited by P. G. Shewmon and V. F. Zackay, 1961. Pp. xii + 491. Price $ 8.00.

*The Abundance of the Elements*. By L. H. Aller, 1961. Pp. xi + 283. Price $ 10.00.

*Advances in Enzymology* (Vol. 23). Edited by F. F. Nord, 1961. Pp. v + 557. Price $ 15.50.

*Thermoelectricity Science and Engineering*. By R. R. Heikes and R. W. Ure, Jr., 1961. Pp. xi + 576. Price $ 18.50.

*Reactor Hand-Book* (2nd Edition, Revised and Enlarged), Vol. II—*Fuel Reprocessing*. Edited by S. M. Stroller and R. B. Richards, 1961. Pp. xii + 665. Price $ 21.40.

*Diazo and Azo Chemistry—Aliphatic and Aromatic Compounds*. By H. Zollinger, Translated by H. E. Nursten, 1961. Pp. 444. Price $ 16.50.

*Euglena—An Experimental Organism for Bio-Chemical and Biophysical Studies*. By Jerome J. Wolken (Institute of Microbiology, Rutgers, The State University, New Burnswick, New Jersey), 1961. Pp. xii + 173. Price $ 4.50.

*College Botany* (Vol. I, 2nd Edition). By H. C. Gangulee, K. S. Das and C. Datta. (The Central Book Agency, 14, Bankim Chatterjee Street, Calcutta-12), 1961. Pp. xxv + 1,087.

*Anthropology in India*. By L. A. Krishna Iyer and L. K. Bala Ratnam. (Bharatiya Vidya Bhavan, Bombay-7), 1961. Pp. xv + 257. Price Rs. 10.

*Science and the Future of Mankind*. Edited by Boyko. (Dr. W. Junk, Publishers, The Hague, Netherlands, 13, Vanstolkweg), 1961. Pp. vii + 380. Price $ 9.50.

# SCIENCE NOTES AND NEWS

### Award of Research Degree

Andhra University has awarded the D.Sc. Degree in Zoology to Shri M. V. Narasimha Rao for his thesis entitled "Cytogenetic Studies in Some Ciliates (Protozoa)".

Utkal University has awarded the Ph.D Degree in Chemistry to Shri R. K. Pattanayak for his thesis entitled "Studies on Some Citrate Complexes"; and Ph.D Degree in Botany to Shri Gopinath Sahu for his thesis entitled "Certain aspects of the Physiology of Growth and Reproduction in Rice".

Osmania University has awarded the Ph.D. Degree in Botany to Shri P. Ramachar for his thesis entitled "A Monographic Study of the Uredinales Parasitizing the Grasses of the Tribe Paniceæ".

### Symposia on "Vacuum Science" and "Nuclear Physics"

The Institute of Physics and the Physical Society announces the following two symposia to be held at Imperial College of Science and Technology, London. (i) A one-day symposium on "Some aspects of vacuum science and technology", on 5th January, 1962. The scope of the symposium will be: (a) continuously exhausted bakeable vacuum apparatus for pressures below $10^{-9}$ mm. of mercury and (b) the controlled deposition of evaporated film.

(ii) A two-day symposium on "High energy nuclear physics", on 26-27 March, 1962. Several review lectures on both theoretical and experimental topics in high-energy nuclear physics will be included in the programme. A limited time will be devoted to short communications.

Further details and application forms may be obtained from the Administration Assistant, The Institute of Physics and the Physical Society, 47, Belgrave Square, London, S.W. 1.

### Symposium on "Ferro-Alloy Industry in India"

The National Metallurgical Laboratory, Jamshedpur (India), is organizing a Symposium on "Ferro-Alloy Industry in India" to be held early in February, 1962. The scope of the Symposium will broadly cover the following with respect to ferro-alloys: Survey of raw materials; Beneficiation of raw materials for indigeneous ferro-alloy industry; Evaluation of production techniques and principles; Latest advances in production technology; Utilisation of by-products; Standard specifications; and Present status of ferro-alloy industry in India and future expansion plans.

Invitations are being extended to technologists, metallurgists and research scientists in India and abroad to attend the Symposium in person and contribute technical papers for discussion. Further particulars can be had from Dr. T. Banerjee, Deputy Director, National Metallurgical Laboratory, Jamshedpur-7.

### Birbal Sahni Institute of Palaeobotany, Lucknow

The Fourteenth Annual Scientific Meeting of the Palaeobotanical Society will be held at the Institute premises on the 21st and 22nd January, 1962. Palæobotanists from all over India are expected to participate, and the programme will include lectures, presentation and discussion of papers, etc.

### Managing Director of Messrs. James A. Jobling and Co. Ltd., Visits India

Messrs. Gordhandas Desai Private Limited, Pherozeshah Metha Road, Bombay-1, Sole Agents in India for PYREX Laboratory and Scientific Glassware, inform us that Mr. J. A. Cochrane, the Deputy Chairman and Managing Director of Messrs. James A. Jobling and Co. Ltd., Sunderland, England, manufacturers of Laboratory Pyrex Glassware, will be visiting India from October 20-28, 1961. Mr. Cochrane, accompanied by Mrs. Cochrane, is on a six-week world goodwill tour visiting their overseas agents and distributors. Their itinerary in India will include Bombay, Delhi, Agra and Culcutta.

### International Rubber Conference

The 'Institut Francais Du Caoutchouc' is organizing, under the ægis of the International Rubber Research and Development Board, an International Rubber Conference to be held in Paris from May 14th to 18th, 1962.

This meeting has two objects in view: (1) to review the latest progress of natural rubber in the field of scientific knowledge, productivity and improvement of qualities; and (2) to compare respective values between natural rubber and synthetic rubbers and thus bring out the prospects in this field.

The I.F.C. has established a programme of "communications" which will be given for the natural rubber by the members of the various Institutes of the I.R.R.D.B. and for the synthetic rubbers by research and technical experts in these products. In addition, plenary Conferences have been arranged during which prominent French and foreign personalities of the rubber world will do the synthesis of the present knowledge. For all informations apply to the Secretariat of the Conference, C/o. Mr. G. Daugy, 42, rue Scheffer, Paris (16).

### A Tetramerous Flower of *Abutilon indicum* Sweet.

Messrs. A. R. Chavan, S. D. Sabnis and S. J. Bedi, Department of Botany, M.S. University of Baroda, Gujarat State, write :

Plants of the family *Malyaceæ* usually exhibit a pentamerous arrangement of the Calyx and corolla whorls. During one of our recent botanical excursions, we were able to collect a flower of *Abutilon indicum*, which showed a tetramerous arrangement. In this flower, the carpels and the monadelphous stamens are normal. The sepals are four and united almost up to the top. The petals are yellow, united up to the middle, three of them being notched at the apex. One of these notched petals is bigger than the rest and approximately double the size of the smallest one.

As far as the authors are aware, no record of a tetramerous and gamopetalous flower in a malvaceous plant is available. In spite of the very meagre material and literature at our disposal, a new record of a tetramerous flower in *Abutilon indicum* is ventured.

### Generation of Optical Harmonics

The development of pulsed ruby optical masers has made possible the production of monochromatic (6943 Å) light beams which, when focused, exhibit eletric fields of the order of $10^5$ volts/cm. The possibility of exploiting this extraordinary intensity for the production of optical harmonics from suitable nonlinear materials is most appealing. In a letter (*Phys. Rev. Letters*, August 15, 1961). Franken *et al.* discuss the requisite analysis and describe experiments in which they have observed the second harmonic (at ~ 3472 Å) produced upon projection of an intense beam of 6943 Å light through crystalline quartz.

A suitable material for the production of optical harmonics must have a nonlinear dielectric coefficient and be transparent to both the fundamental optical frequency and the desired overtones.

Since all dielectrics are nonlinear in high enough fields, this suggests the feasibility of utilizing materials such as quartz and glass.

In the experiments they have used a commercially available ruby optical maser which produces 3 joules of 6943 Å light in a one millisecond pulse. This light is passed through a red filter for the elimination of the xenon flash background and is then brought to a focus inside a crystalline quartz sample. The emergent beam is analysed by a quartz prism spectrometer equipped with red insensitive Eastman type 103 spectrographic plates. The plate showed an unambiguous indication of second harmonic (3472 Å).

Theoretical prediction as developed in the paper is confirmed by the following two facts. (1) The light at 3472 Å disappears when the quartz is removed or is replaced by glass, (2) The light at 3472 Å exhibits the expected dependence on polarization and orientation.

### New Moons

Polish astronomer K. Kordylewski of the Cracow Observatory has reported the discovery of two cloud-like objects that appear to be natural satellites of the earth. They lie in the same orbit as the moon and just at a point where an 18th century mathematical analysis predicted they might be found.

In 1772 the French mathematician and astronomer Joseph Louis Lagrange calculated that there are five points of gravitational equilibrium around a pair of massive bodies. These are since known as Lagrange points and designated by the letter L. Three of these correspond to crests of a hill and represent an unstable equilibrium. Two, $L_4$ and $L_5$ are gravitational pits ; a small body in either position tends to stay there. In the case where one of the massive bodies revolves around the other, $L_4$ and $L_5$ lie on the orbit, respectively 60° ahead of and behind the revolving body.

In 1904 a small mass was found oscillating around the $L_4$ point of the Sun-Jupiter system. It was one of the Trojan asteroids of which 11 others have since been identified, some at $L_4$ and others at the $L_5$ point behind Jupiter.

Kordylewski looked for similar objects in the earth-moon system. After several years of searching he photographed, last March and April, two faint clouds circling the earth at the $L_5$ point behind the moon. This discovery was announced at the International Astronomical

Union. The satellites appear to be collections of meteoritic material. Kordylewski suggests that similar satellites may be found at the $L_4$ point ahead of the moon, which will next be in position for observation from the earth beginning in September.—(*Scientific American*, August 1961.)

### Spark Chamber

A new detector called the *spark chamber* on which currently experiments are going on promises to be a worthy competitor to the bubble chamber. It consists of a set of parallel conducting plates, set about half an inch apart in a vessel containing gas such as neon. Alternate plates are connected to opposite sides of a generator, producing a potential of about 10,000 volts between each pair. When a charged particle passes through the array, it leaves a segmented trail of ionized gas atoms between the plates. Each segment acts as a nucleus for a localized spark that jumps from one plate to the next. By photographing the tracks of sparks from two perpendicular directions, the three-dimensional path followed by the particle can be reconstructed.

This arrangement has several advantages. It is simple. It operates at atmospheric pressure. Neither the gas nor the plate material need be highly purified, and the exact shape of the plates is not critical.

The spark trail is not so fine as those in cloud or bubble chambers; hence its space resolution is poorer. But the time resolution is thousands of times better. The high voltages on the plates can be applied in pulses lasting only a ten-millionth of a second. Between pulses a small, steady voltage sweeps the gas clear of ions. Therefore only the particles passing through the chamber during the time of the pulse leave visible tracks.

The first working spark chamber was built in 1959 by S. Fukui and S. Miyamoto in Japan. Currently a 10-ton spark chamber made of 100 aluminium plates each 4 ft. square and 1 inch thick, is being assembled in the Colombia University. The device will be used in conjunction with the 30 BeV synchrotron at the Brookhaven National Laboratory in experiments on high-energy neutrinos.—(*Scientific American*, July 1961.)

### On Possible Parent Substances for the $C_2$ Molecules Observed in the Alphonsus Crater

*Apropos* Kozyrev's observation of the fluorescent Swan bands emitted by gases escaping from the Alphonsus crater of the moon, it is of interest to inquire as to what compounds might be coming from the lunar interior which would supply the $C_2$ molecules responsible for the Swan bands. H. C. Urey in a note in *Astrophysical Journal*, 1961, Vol. 134, p. 268, examines the various possibilities.

Volatalization of graphite would require very high temperatures, and no satisfactory evidence for such temperatures has been presented. Since molecular collisions can hardly occur after the gas becomes exposed to sunlight because of the low pressures, $C_2$ can hardly be formed during collisions between molecules containing only one atom of carbon. Hence methane or other molecules containing a single atom of carbon cannot be the parent molecules.

The next molecule to consider would be acetylene, $C_2H_2$. But this is a very unstable molecule relative to dissociation into its elements and can hardly have been stored as such for a long period of time. It is made in terrestrial laboratories by the action of water on calcium carbide, $CaC_2$. Calcium carbide or other alkali or alkaline earth carbides could be expected to be retained in the absence of water for long times, and if water now comes from the lunar interior and makes contact with such carbide, acetylene would appear at the lunar surface. Ferrosilicon and silicon carbide are found in meteorites, and the conditions for the production of these compounds from silicon dioxide and of calcium carbide from calcium oxide are similar. Thus if material now near the surface of the Alphonsus crater have been subjected to processes similar to those required for certain of the meteorites, acetylene may be the parent molecule of the $C_2$ molecule.

Urey also examines the possibilties of $C_2H_4$, $C_2H_6$ and higher hydrocarbons being the parent substance for the production of $C_2$ and comes to the conclusion that although it is not possible to state what the parent substance or substances of the $C_2$ molecules observed by Kozyrev are, it would be interesting to make tests for calcium carbide in Lunar surface materials by early landings of the instruments on the moon.

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